Low-Level Phased Array Radio Frequency Epidemiology Studies

1.) B. Appleton, S. Hirsch, R. O. Kinion, M. Soles, G. C. McCrossan and R. M. Neidlinger. Microwave lens effects in humans. II. Results of five-year survey. Arch Ophthalmol. 1975. 93(4): 257-8.

Individuals selected on the basis of likelihood of occupational exposure to microwaves were subjected to a biomicroscopic examination of the lens. Control personnel were also examined along with them, the examiners having no knowledge of the exposure history of any examinee prior to or during the examination. Objective evidence of lens abnormality (opacities, vacuoles, or posterior subcapsular iridescence) was recorded and a comparison made between the two groups on the basis of that evidence. The comparison showed the two groups to be essentially the same and did not support the hypothesis that human lens damage is occurring in the military environment in this country. Instead, it tended to support the assumption that the existing safety level of 10 MW/sq cm is adequate.

2.) B. B. Arnetz and M. Berg. Melatonin and adrenocorticotropic hormone levels in video display unit workers during work and leisure. J Occup Environ Med. 1996. 38(11): 1108-10.

This study examined 47 office workers during a day of regular work in front of a video display unit (VDU) and a day of leisure in the same environment. The study investigated possible effects of VDU work on circulating melatonin and adrenocorticotropic hormone (ACTH) levels. Circulating melatonin levels decreased significantly during VDU work, whereas ACTH levels increased significantly. In contrast, melatonin and ACTh levels did not change significantly during a day of leisure. Mental strain during work was significantly and positively associated with circulating levels of ACTH but not melatonin. The results indicate that the VDU environment is associated with measurable changes in melatonin and ACTH levels. Mental strain might explain changes in ACTH levels, but specific factors that might contribute to changes in melatonin levels are unknown. These findings might be relevant to the recent debate about the possible influence that electromagnetic and VDU environments might have on electromagnetic sensitivity.

3.) A. Bortkiewicz, E. Gadzicka and M. Zmyslony. Heart rate variability in workers exposed to medium-frequency electromagnetic fields. J Auton Nerv Syst. 1996. 59(3): 91-7.

This study was undertaken to evaluate the neurovegetative regulation of the heart in workers occupationally exposed to medium frequency (MF) electromagnetic (EM) fields. The subjects were 71 workers of MF broadcast stations, aged 20-68 (mean 47.1) with the duration of work under exposure ranging from 2-40 years and 22 workers of radio link stations, aged 21-65 (mean 46.9) who were not exposed to MF EM fields. The distribution of age and work tenure in both groups did not differ significantly. Heart rate variability (HRV) was analysed basing on 512 normal heart evolutions registered in resting, from the body surface, using the Medea-HRV system. The analysis concerned time-domain and frequency-domain parameters of HRV using fast fourier transformation. Power spectrum in the low (0.05-0.15 Hz) and high (0.15-0.35 Hz) frequency bands (LF

and HF, respectively) was determined. Statistically insignificant differences found between exposed and non-exposed groups were found either in time- or in frequency-domain parameters of HRV. No correlation between the power spectrum and the subjects age was noted. Such a relationship, however, could be observed in the control group. In the study group a statistically significant negative correlation was found between the maximum intensity of EM fields and HF power spectrum. Thus it was concluded that occupational exposure to EM fields brings about impairments in the neurovegetative regulation of the cardiovascular function.

4.) A. Bortkiewicz, M. Zmyslony, E. Gadzicka, C. Palczynski and S. Szmigielski. Ambulatory ECG monitoring in workers exposed to electromagnetic fields. J Med Eng Technol. 1997. 21(2): 41-6.

The aim of this study was to evaluate the function of the circulatory system in workers occupationally exposed to medium frequency electromagnetic fields. The subjects were 71 workers at four AM broadcast stations [0.738-1.503 MHz] aged 20-68 (mean 46.9 +/- 13.1) years and 22 workers at radio link stations aged 23-67 (mean 48.2 +/- 17.4) years. Workers at AM broadcast stations experienced 2-40 (mean 18.6 +/- 12.1) years' exposure to electromagnetic fields (average daily exposure dose about 115 Vh m-1, maximum exposure levels during shift about 165 V m-1), workers at radio link stations had no history of regular exposure to electromagnetic fields. In all the subjects a general medical examination, resting ECG and 24 h Holter monitoring were performed. The work organization, work period structure, age, lifestyle, nutritional habits and health status in both groups remained fairly similar. The electrocardiographic abnormalities detected in the resting and/ or 24 h ECG were significantly more frequent ($p = 0.006$) in workers exposed to electromagnetic fields than in non-exposed subjects (75% versus 25%). A clear tendency for a higher number of rhythm disturbances (mostly ExV) was observed in AM broadcast station workers.

5.) H. E. Bryant and E. J. Love. Video display terminal use and spontaneous abortion risk. Int J Epidemiol. 1989. 18(1): 132-8.

A matched case-control study investigated the potential effects of video display terminal (VDT) use on risk of spontaneous abortion in pregnancy. Structured interviews were administered to 334 cases immediately following a miscarriage. For each case, two age and parity- matched controls were enrolled, the first being a woman still pregnant (less than 25 weeks' gestation), and the second a woman in the postpartum ward of the same participating hospital. Separate analyses were carried out for each comparison group due to potential and observed differences in recall loss and selection bias. The overall exposure to VDT's during the period of interest (three months preceding the last menstrual period [LMP] to four months post-LMP) did not indicate an increased risk for either control group comparison (OR = 1.14, $p = 0.47$ with postnatal controls; OR = 0.80, $p = 0.20$ with prenatal controls). Furthermore, when exposure data were re-classified to remove women with distant or single exposures, no significant odds ratios were found. While several socioeconomic and obstetric variables were significantly associated with VDT use, multivariate analysis did not alter the lack of association of VDT use with case-control status. Finally, evidence for recall bias in postnatal control reporting, evidenced by underreporting of trivial exposures in this group, is examined.

6.) G. R. Bunin, E. Ward, S. Kramer, C. A. Rhee and A. T. Meadows. Neuroblastoma and parental occupation. Am J Epidemiol. 1990. 131(5): 776-80.

A matched case-control study of neuroblastoma investigated parental occupational risk factors. Cases diagnosed in 1970-1979 were identified through tumor registries in the Greater Philadelphia area. Controls were selected by random digit dialing and were matched to cases on race, birth date, and telephone exchange. Parents of 104 matched pairs were interviewed by telephone. In contrast to results of a previous study, no significant associations were noted for paternal employment in a job cluster of occupations in electricity, electronics, insulation, utility, and printing; in jobs with electromagnetic field exposure; or in jobs as workers in electronics. Six cases and one control, however, had a father or mother who worked in electrical or electronic products assembly.

7.) R. G. Burr and A. Hoiberg. Health profile of U.S. Navy pilots of electronically modified aircraft. Aviat Space Environ Med. 1988. 59(2): 168-71.

This study compared hospitalization rates of pilots who primarily flew electronically modified aircraft (n = 1,063) with an age-matched group of pilots who flew other types of aircraft (n = 2,126). Of the two groups, control pilots at ages 21-26 had a significantly higher mortality rate for aviation-related injuries and a higher hospitalization rate for the diagnostic category of accidents, poisonings, and violence. Their hospitalization rates also were significantly higher than pilots of electronically modified aircraft for mental disorders at ages 27-32 and supplementary classifications at ages 39-44. Significant age-specific increases in rates were observed for cardiovascular disease and alcoholism in the control group whereas no significant increases were noted for pilots of electronic models. Pilots in the latter group had low rates for conditions postulated as related to radiation exposure. Such results indicated that pilots of electronically modified aircraft were not at increased risk for illness or injury because of the aircraft models they primarily flew.

8.) K. P. Cantor, P. A. Stewart, L. A. Brinton and M. Dosemeci. Occupational exposures and female breast cancer mortality in the United States. J Occup Environ Med. 1995. 37(3): 336-48.

Mortality records from 24 states, gathered from 1984 to 1989 and coded for occupation and industry, were used to develop leads to workplace exposures as possible breast cancer risk factors. A case-control approach was used, with separate analyses for blacks and whites. After excluding homemakers, 33,509 cases and 117,794 controls remained. A job exposure matrix was used to estimate the probability and level of 31 workplace exposures. After adjusting for socioeconomic status, suggestive associations for probability and level of exposure were found for styrene, several organic solvents (methylene chloride, carbon tetrachloride, formaldehyde), and several metals/metal oxides and acid mists. Because of the methodologic limitations of this study, its primary value is in suggesting hypotheses for further evaluation. The findings for styrene, selected solvents, and metals and metal-related exposures deserve additional study.

9.) M. F. Chiang, M. Brock and S. Patt. Pituitary metastases. Neurochirurgia (Stuttg). 1990. 33(4): 127-31.

Over the past 12 years we encountered three histologically confirmed pituitary metastases. Primary cancer had been diagnosed and treated previously in only one patient. In the remaining two a transsphenoidal operation provided the initial diagnosis of metastasis, and the primary lesion was subsequently detected at autopsy in one. In two of the three patients symptoms and signs of pituitary dysfunction were the first manifestations of the malignant disease. The main symptoms and signs were impairment of visual acuity, visual field defect, headache, adenohypophyseal insufficency and diabetes insipidus. A sellar mass was demonstrated by CT or MRI in all patients. The tumours were all completely extirpated by subfrontal route in one case and transsphenoidally in the remaining two patients. Following surgery the presenting symptoms improved satisfactorily in all patients.

10.) R. L. Davis and F. K. Mostofi. Cluster of testicular cancer in police officers exposed to hand-held radar. Am J Ind Med. 1993. 24(2): 231-3.

Within a cohort of 340 police officers, six incident cases of testicular cancer occurred between 1979 and 1991 (O/E 6.9; $p < 0.001$, Poisson distribution). Occupational use of hand-held radar was the only shared risk factor among all six officers, and all routinely held the radar gun directly in close proximity to their testicles. Health effects of occupational radar use have not been widely studied, and further research into a possible association with testicular cancer is warranted.

11.) L. De Guire, G. Theriault, H. Iturra, S. Provencher, D. Cyr and B. W. Case. Increased incidence of malignant melanoma of the skin in workers in a telecommunications industry. Br J Ind Med. 1988. 45(12): 824-8.

In 1982 physicians at a hospital melanoma clinic in Montreal noticed that among their patients there had been seven men working in a single telecommunications company. This raised suspicions that working in that industry might be associated with development of malignant melanoma of the skin (MMS). A preliminary gross comparison with general population rates indicated that there was an increased risk in this working group. To estimate the risk of MMS more accurately, a standardised incidence ratio (SIR) was calculated based on the rates of MMS in the local population of the Greater Metropolitan Montreal Area for the years 1976- 83. During that period, among workers in all plants for the company, 10 male cases of MMS were observed for an expected number of 3.7 (SIR = 2.7; 95% CI = 1.31-5.02). No cases were observed among female workers (expected = 1.3). The excess was significant among cases with a short latency (less than 20 years since beginning of employment). There was no apparent pattern of exposure based on job titles or departments.

12.) A. J. De Roos, K. Teschke, D. A. Savitz, C. Poole, S. Grufferman, B. H. Pollock and A. F. Olshan. Parental occupational exposures to electromagnetic fields and radiation and the incidence of neuroblastoma in offspring. Epidemiology. 2001. 12(5): 508-17.

We examined parental occupational exposures to electromagnetic fields and radiation and the incidence of neuroblastoma in offspring. Cases were 538 children diagnosed with neuroblastoma between 1992 and 1994 in the United States or Canada. Age-matched controls were selected by random-digit dialing. Occupational exposures to electrical equipment and radiation sources were classified by an industrial hygienist, and average exposures to extremely low frequency magnetic fields were estimated using a job exposure matrix. Maternal exposure to a broad grouping of sources that produce radiofrequency radiation was associated with an increased incidence of neuroblastoma (odds ratio = 2.8; 95% confidence interval = 0.9-8.7). Paternal exposure to battery-powered forklifts was positively associated with neuroblastoma (odds ratio = 1.6; 95% confidence interval = 0.8-3.2), as were some types of equipment that emit radiofrequency radiation (odds ratios congruent with 2.0); however, the broad groupings of sources that produce ELF fields, radiofrequency radiation, or ionizing radiation were not associated with neuroblastoma. Paternal average extremely low frequency magnetic field exposure >0.4 microTesla was weakly associated with neuroblastoma (odds ratio = 1.6; 95% confidence interval = 0.9-2.8), whereas maternal exposure was not. Overall, there was scant supportive evidence of strong associations between parental exposures in electromagnetic spectrum and neuroblastoma in offspring.

13.) P. A. Demers, D. B. Thomas, K. A. Rosenblatt, L. M. Jimenez, A. McTiernan, H. Stalsberg, A. Stemhagen, W. D. Thompson, M. G. Curnen, W. Satariano and et al. Occupational exposure to electromagnetic fields and breast cancer in men. Am J Epidemiol. 1991. 134(4): 340-7.

Data from a population-based case-control study of breast cancer in men were used to examine the hypothesis that occupational exposure to electromagnetic fields increases the risk of breast cancer. Incident cases (n = 227) diagnosed between 1983 and 1987 were obtained from 10 population-based cancer registries of the Surveillance, Epidemiology, and End Results program of the National Cancer Institute. Controls (n = 300) were selected by random digit dialing and from Medicare eligibility lists. Exposure status, defined as ever having been employed in a job which has been classified as involving potential exposure to electromagnetic fields, was assigned without knowledge of case/control status. An elevated risk was found for any job with exposure (odds ratio (OR) = 1.8, 95 percent confidence interval (CI) 1.0-3.7), and risk was highest among electricians, telephone linemen, and electric power workers (OR = 6.0, 95 percent CI 1.7-21) and radio and communications workers (OR = 2.9, 95 percent CI 0.8-10). Risk did not vary with duration of exposed employment. The risk was highest among subjects who were first employed in jobs with exposure before the age of 30 years and who were initially exposed at least 30 years prior to diagnosis. These results lend support to the theory that electromagnetic fields may be related to breast cancer in men. The hypothesis warrants evaluation in women.

14.) Z. Djordjevic, A. Kolak, M. Stojkovic, N. Rankovic and P. Ristic. A study of the health status of radar workers. Aviat Space Environ Med. 1979. 50(4): 396-8.

The health status was examined of 322 radar workers with a history of occupational exposure in a microwave field from 5-10 years. The clinical findings were compared with a control group of 220 persons. There were no statistically significant differences in clinical and laboratory findings between exposed and control group. Only some

subjective complaints were found more frequently in the exposed group than in the control. The authors' feeling is that subjective complaints in radar workers could not be ascribed only to the influence of microwaves because they could be due to other nonspecific harmful occupational factors. On the basis of the results of this work, the authors concluded that it is unlikely to expect marked harmful effects from microwaves in radar workers in normal working conditions.

15.) Z. Djordjevic, A. Kolak, V. Djokovic, P. Ristic and Z. Kelecevic. Results of our 15-year study into the biological effects of microwave exposure. Aviat Space Environ Med. 1983. 54(6): 539-42.

The results obtained during 15 years of clinical and experimental examinations of biological microwave exposure effects are briefly surveyed. Some important results are reported. Based on their experience, the authors present their attitudes concerning harmful microwave effects on living matter. They consider that microwave effects, either direct or indirect, are the results of hyperthermia. Exposure of the living body to irradiation intensities not causing thermal effects do not induce important pathological alterations in the irradiated organisms. Also, it has been pointed out that the term "injury" is more suitable than the term "microwave sickness" when harmful effects of microwaves to the living organism are concerned. According to the authors, the term "microwave sickness" is not acceptable as a synonym for professional diseases of persons working with sources of microwave energy, since it refers to the complex of insufficiently defined symptoms of uncertain etiology.

16.) H. Dolk, G. Shaddick, P. Walls, C. Grundy, B. Thakrar, I. Kleinschmidt and P. Elliott. Cancer incidence near radio and television transmitters in Great Britain. I. Sutton Coldfield transmitter. Am J Epidemiol. 1997. 145(1): 1-9.

A small area study of cancer incidence in 1974-1986 was carried out to investigate an unconfirmed report of a "cluster" of leukemias and lymphomas near the Sutton Coldfield television (TV) and frequency modulation (FM) radio transmitter in the West Midlands, England. The study used a national database of postcoded cancer registrations, and population and socioeconomic data from the 1981 census. Selected cancers were hematopoietic and lymphatic, brain, skin, eye, male breast, female breast, lung, colorectal, stomach, prostate, and bladder. Expected numbers of cancers in small areas were calculated by indirect standardization, with stratification for a small area socioeconomic index. The study area was defined as a 10 km radius circle around the transmitter, within which 10 bands of increasing distance from the transmitter were defined as a basis for testing for a decline in risk with distance, and an inner area was arbitrarily defined for descriptive purposes as a 2 km radius circle. The risk of adult leukemia within 2 km was 1.83 (95% confidence interval 1.22- 2.74), and there was a significant decline in risk with distance from the transmitter ($p = 0.001$). These findings appeared to be consistent over the periods 1974-1980, 1981-1986, and were probably largely independent of the initially reported cluster, which appeared to concern mainly a later period. In the context of variability of leukemia risk across census wards in the West Midlands as a whole, the Sutton Coldfield findings were unusual. A significant decline in risk with distance was also found for skin cancer, possibly related to residual socioeconomic confounding, and for bladder cancer. Study of other radio and TV

transmitters in Great Britain is required to put the present results in wider context. No causal implications can be made from a single cluster investigation of this kind.

17.) H. Dolk, P. Elliott, G. Shaddick, P. Walls and B. Thakrar. Cancer incidence near radio and television transmitters in Great Britain. II. All high power transmitters. Am J Epidemiol. 1997. 145(1): 10-7.

A small area study of cancer incidence, 1974-1986, near 20 high power television (TV) and frequency modulation (FM) radio transmitters in Great Britain was carried out to place in context the findings of an earlier study around the Sutton Coldfield transmitter. The national database of postcoded cancer registrations was used with population and socioeconomic data from the 1981 census. Cancers examined were adult leukemias, skin melanoma, and bladder cancer, following the findings in the earlier study of significant declines in risk of these cancers with distance from the Sutton Coldfield transmitter. Childhood leukemia and brain cancer were also examined. Statistical analysis was performed for all transmitters combined, four overlapping groups of transmitters defined by their transmission characteristics, and for all transmitters separately. There were 3,305 adult leukemia cases from 0-10 km (observed/expected (O/E) ratio = 1.03, 95% confidence interval (CI) 1.00-1.07). A decline in risk of adult leukemia was found for all transmitters combined (p = 0.05), two of the transmitter groups, and three of the single transmitters; for all transmitters combined, observed excess risk was no more than 15% at any distance up to 10 km, and there was no observed excess within 2 km of transmitters (O/E ratio = 0.97, 95% CI 0.78-1.21). For childhood leukemia and brain cancer, and adult skin melanoma and bladder cancer, results were not indicative of a decline in risk with distance from transmitters. The magnitude and pattern of risk found in the Sutton Coldfield study did not appear to be replicated. The authors conclude that the results at most give no more than very weak support to the Sutton Coldfield findings.

18.) M. M. Doody, J. S. Mandel and J. D. Boice, Jr. Employment practices and breast cancer among radiologic technologists. J Occup Environ Med. 1995. 37(3): 321-7.

A case-control study of breast cancer and employment practices among female radiologic technologists was conducted. The cohort from which cases and controls were derived included over 105,000 female medical radiation workers certified by the American Registry of Radiologic Technologists during 1926-1980. Breast cancer cases (n = 528) were individually matched to an average of five control subjects (n = 2628) based on year of birth, year of certification, and length of follow-up. Procedures most commonly performed by controls included fluoroscopy (93%), portable radiographs (92%), routine radiographs (92%), multifilm procedures (87%), dental x-rays (46%), radium therapy (31%), orthovoltage (23%), and cobalt-60 (21%). Breast cancer was not significantly increased with occupational experience with any of these procedures. Furthermore, risk was not related to number of years worked with a particular procedure. This study is reassuring in indicating that medical radiation workers are not at substantial risk for developing radiation-induced breast cancer. However, because only surrogate measures of radiation exposure were available, possibility of a small risk cannot be discounted. Ongoing follow-up of this cohort for incident cancers will incorporate detailed exposure assessment schemes, providing additional information on effects of long-term low-dose radiation through occupation.

19.) A. Ericson and B. Kallen. An epidemiological study of work with video screens and pregnancy outcome: I. A registry study. Am J Ind Med. 1986. 9(5): 447-57.

Three cohorts of women were identified with the aid of occupational codes in the census, linked to the Medical Birth Registry and an Inpatient Registry, containing information on women hospitalized for spontaneous abortion. The three cohorts were selected from the same socioeconomic stratum but had different probabilities to be exposed for video screen work: high, medium, and low. The total pregnancy outcome of the three groups of women did not differ significantly, but there was a weak trend for more spontaneous abortions and perhaps also for congenital malformations in the group with the highest video screen work exposure; however, the differences could be random. Comparisons of delivery outcomes for these cohorts in 1976-77 with those in 1980-81 did not show any consistent pattern in spite of the heavy computerization of these workplaces which occurred between the two time periods. The second part of this report studies the material in further detail.

20.) A. Ericson and B. Kallen. An epidemiological study of work with video screens and pregnancy outcome: II. A case-control study. Am J Ind Med. 1986. 9(5): 459-75.

A case-control study on work with video screen equipment during pregnancy has been made for three cohorts of women, identified with the aid of occupational codes in the census, linked to the Medical Birth Registry and a registry containing information on women hospitalized for spontaneous abortion. Five hundred and twenty-two cases were selected (women with spontaneous abortions or women who had infants that died, had severe malformations, or had a birth-weight below 1,500 g) and 1,032 controls (women who had infants without any of these characteristics) taken from the same age stratum as the cases. All pregnancies had occurred in 1980-81. Questionnaires were mailed to the women asking for information on their work situation, including questions about work with video screen equipment. Fifty-eight women were excluded for various reasons. Response rate was 93%--lower (89%) among women with spontaneous abortions than among women who gave birth (95%). As stress and smoking were associated with video screen work, the effect of video screen work was analyzed after stratification for stress and smoking--no statistically significant effect of video screen work was seen but odds ratios were above 1. Crude odds ratios for video screen work were significantly elevated and showed a dose-dependent effect. This finding is discussed from the point of view of biases in the study: selective non-responding, recall bias, geographical variability, and lack of information on women who had induced abortions. Using questionnaire data for exposure rates in the populations studied, an estimate of the effect greater than or equal to 10 hr weekly work with video screens on spontaneous abortion rate was made. The point estimate was 1.04 with a 95% confidence interval of 0.9- 1.2. Analysis of 44 infants with birth defects whose mothers had worked more than 10 hr/week with video screen equipment compared to 30 infants with birth defects whose mothers had not used such equipment in early pregnancy showed no signs of specificity in the type of birth defect.

21.) A. H. Frey. Data analysis reveals significant microwave-induced eye damage in humans. J Microw Power Electromagn Energy. 1985. 20(1): 53-5.

Appleton and McCrossan undertook a study for the U.S. Army at Ft. Monmouth to determine if microwave exposure would cause cataracts. They concluded: "The comparison showed the groups (microwave exposed vs. not exposed) to be essentially the same and did not support the hypothesis that human cataracts are being caused by chronic exposure to microwaves in the military environment in this country." There are three major flaws in Appleton and McCrossan's work. First, the exposed group likely included people with little or no exposure. This would tend to minimize the possibility of finding microwave effects. Secondly, their control group consisted of people working with equipment known to cause eye damage. This also would tend to minimize the possibility of finding microwave effects. Thirdly, and most important, they did not do a statistical analysis on their data. When the writer did one, it was found that Appleton and McCrossan have a statistically significant difference between groups, with the microwave exposed showing more lens opacities than would be expected by chance. Thus, their conclusion should have been the opposite of what they stated. It is the uncritical acceptance of negative biological studies of non-ionizing radiation, such as this, that has contributed to the distortion of science in this area of research and has stimulated public opposition to the installation of such energy sources.

22.) F. C. Garland, E. D. Gorham and C. F. Garland. Hodgkin's disease in the US Navy. Int J Epidemiol. 1987. 16(3): 367-72.

Hodgkin's disease incidence has an early peak in young adulthood. The US Navy maintains computerized career history and hospitalization information for one of the largest defined populations of young adults available for prospective studies. There were approximately 2.3 million person-years at risk in white male enlisted personnel involved in more than 80 occupations in the Navy from 1974-79. During this period 88 incident cases were identified. Navy age-adjusted incidence rates of Hodgkin's disease did not differ significantly from US population rates. There was a slight, but not significant, increased incidence with increasing length of Navy service. One occupation, machinists' mate, had about double the risk of Hodgkin's disease as the entire Navy (SIR = 2.3, p = 0.004) and the US population (SIR = 1.8, ns). Probable exposures of machinists' mates include: volatile solvents, metal dusts and, possibly, ionizing radiation. Further studies are needed, however, to clarify this association.

23.) F. C. Garland, E. D. Gorham, C. F. Garland and J. A. Ferns. Non-Hodgkin's lymphomas in U.S. Navy personnel. Arch Environ Health. 1988. 43(6): 425-9.

Non-Hodgkin's lymphomas are one of the most commonly occurring cancers in the age groups heavily represented in the U.S. Navy. The Navy has a wide range of potential occupational exposures. This study was initiated to identify any occupational associations of non-Hodgkin's lymphomas that may adversely affect naval readiness. The objective of this study was to compare the incidence of non-Hodgkin's lymphomas in U.S. Navy active duty enlisted personnel during the period 1974-1983 with the general U.S. population, and to assess if risk varied by naval occupation or length of service. The Naval Health Research Center's computer-based disease registry was used to conduct a prospective study of all white U.S. Navy enlisted men during 1974-1983 to test for the existence of any short-term risk possibly due to occupation. Men in 80 occupations, ranging from clerk to journalist to machinist and boiler operator were observed for 3,704,864 person-years; mean length of service was 5.1 yr, but 19% of

person-years were contributed by men who had served at least 11 yr. Incident cases of non-Hodgkin's lymphomas were identified and verified using Medical Board findings or review of original medical records. Average annual age-specific and age-adjusted incidence rates were calculated. Examination of pathology records and medical review boards confirmed 68 cases of non-Hodgkin's lymphomas. The annual age-adjusted incidence rate per 100,000 person-years in Navy men was significantly lower than in the U.S. Surveillance, Epidemiology, and End Results (SEER) population, probably due to screening and other selection factors associated with Navy service that result in a healthy worker effect.(ABSTRACT TRUNCATED AT 250 WORDS)

24.) F. C. Garland, E. Shaw, E. D. Gorham, C. F. Garland, M. R. White and P. J. Sinsheimer. Incidence of leukemia in occupations with potential electromagnetic field exposure in United States Navy personnel. Am J Epidemiol. 1990. 132(2): 293-303.

Leukemia is the fourth most commonly occurring cancer in the United States population between the ages of 17 and 34 years, an age group heavily represented in the US Navy. Historical computerized military career records maintained at the Naval Health Research Center, San Diego, California, were used to determine person-years at risk (total, 4,072,502 person-years) by demographic characteristics and occupation for active-duty naval personnel during 1974-1984. Computerized inpatient medical records were searched for first hospitalizations for leukemia. Cases of leukemia (n = 102) were verified by using pathology reports or Navy Medical Board or Physical Evaluation Board findings. For comparisons, age-adjusted incidence rates and standardized incidence ratios were calculated by using rates for the US population provided by the Surveillance, Epidemiology, and End Results program of the National Cancer Institute. The overall age-adjusted incidence rate of leukemia in active-duty naval personnel was found to be very close to that of the Surveillance, Epidemiology, and End Results program population (6.0 vs. 6.5 per 100,000 person-years). Only one occupation, electrician's mate, emerged with a borderline statistically significant excess risk of leukemia (standardized incidence ratio compared with the Surveillance, Epidemiology, and End Results program population = 2.4, 95% confidence interval 1.0-5.0). This finding is intriguing in the light of several studies showing an excess risk of leukemia associated with exposure to electromagnetic fields.

25.) O. M. Garson, T. L. McRobert, L. J. Campbell, B. A. Hocking and I. Gordon. A chromosomal study of workers with long-term exposure to radio- frequency radiation. Med J Aust. 1991. 155(5): 289-92.

OBJECTIVE: To examine whether an increased level of chromosome damage occurs in the stimulated lymphocytes of radio-linemen after long-term but intermittent exposure to radio-frequency radiation (RFR) during the course of their work. DESIGN AND PARTICIPANTS: Chromosome studies were performed on blood samples from 38 radio-linemen matched by age with 38 controls, all of whom were employed by Telecom Australia. The radio- linemen had all worked with RFR in the range 400 kHz-20 GHz with exposures at or below the Australian occupational limits, and the controls were members of the clerical staff who had no exposure to RFR. Two hundred metaphases from each subject were studied and chromosome damage was scored by an observer who was blind to the status of the subjects. RESULTS: The ratio of the rate of aberrant cells in the radio- linemen group to that in the control group was 1.0 (95% confidence interval, 0.8-

1.3). There were no statistically significant differences in the types of aberrations that were scored. CONCLUSION: Exposure to RFR at or below the described limits did not appear to cause any increase in chromosomal damage in circulating lymphocytes.

26.) M. K. Goldhaber, M. R. Polen and R. A. Hiatt. The risk of miscarriage and birth defects among women who use visual display terminals during pregnancy. Am J Ind Med. 1988. 13(6): 695-706.

Use of visual display terminals (VDTs) was examined in a case-control study of pregnancy outcome among 1,583 pregnant women who attended three Kaiser Permanente obstetrics and gynecology clinics in Northern California, 1981-1982. We found a significantly elevated risk of miscarriage for working women who reported using VDTs for more than 20 hr per week during the first trimester of pregnancy compared to other working women who reported not using VDTs (odds ratio 1.8, 95% CI: 1.2- 2.8). This risk could not be explained by age, education, occupation, smoking, alcohol consumption, or other maternal characteristics. No significantly elevated risk for birth defects was found among working women although odds ratios were 1.4 for both moderate and high VDT exposure, compared with no exposure (95% CI: 0.7-2.7 and 0.7-2.9, respectively). One possible explanation for these findings is that women who had adverse pregnancy outcomes may have overreported their exposures to VDTs and/or women with normal births may have underreported theirs. The findings may also be due to unmeasured factors confounded with high VDT use such as poor ergonomic conditions or job-related stress. That VDTs themselves are hazardous to the pregnant operator remains a possibility. Our results underscore the need for large cohort studies of working women that will provide objective measures of VDT exposures, ergonomic factors, and stress.

27.) J. Goldoni, J. Bobic and M. Saric. Psychological and ergonomic aspects of work with video display terminals. Arh Hig Rada Toksikol. 1992. 43(3): 219-26.

Forty-nine operators of video display terminals were administered a questionnaire on subjective complaints in connection with work conditions. Measurements of non-ionizing and ionizing radiation emissions during normal operation of video display terminals showed them to be within permissible levels. A detailed ergonomic analysis of equipment and workstations was also performed. Results showed a high occurrence of subjective complaints, significant differences between age subgroups in a few variables, and significant correlation between sets of variables of some perceived ergonomic features and subjective complaints.

28.) J. Goldoni, M. Durek and Z. Koren. Health status of personnel occupationally exposed to radiowaves. Arh Hig Rada Toksikol. 1993. 44(3): 223-8.

The findings of medical examinations performed in two groups of persons occupationally exposed to microwaves and radiofrequency radiation are presented in comparison with control findings. A group of 49 radar operators from the Zagreb Air Traffic Control was examined twice within a period of 18 months. The other group comprised 46 workers employed in radio relay stations. The control group were 46 workers from the Zagreb Airport. A follow-up study showed significant changes in haematological and biochemical

parameters, in electrical brain activity and in capillaroscopic and ophthalmological findings in the group of radar operators within the followed period. For that group a cross-sectional study of the differences in general health status also showed the highest rate of changes. The results indicate that long-term occupational exposure to microwaves and radiofrequencies may damage sensitive organic systems.

29.) B. Grajewski, C. Cox, S. M. Schrader, W. E. Murray, R. M. Edwards, T. W. Turner, J. M. Smith, S. S. Shekar, D. P. Evenson, S. D. Simon and D. L. Conover. Semen quality and hormone levels among radiofrequency heater operators. J Occup Environ Med. 2000. 42(10): 993-1005.

Approximately 9,000,000 US workers are occupationally exposed to radiofrequency (RF) radiation; over 250,000 operate RF dielectric heaters. Our purpose was to determine whether male RF heater operators experience increased adverse reproductive effects reflected in reduced semen quality or altered hormone levels. We measured incident RF heater radiation exposures and RF-induced foot currents at four companies. For 12 male heater operators and a comparison group of 34 RF-unexposed men, we measured 33 parameters of semen quality and four serum hormones. Despite wide variation in individual exposure levels, near field strengths and induced foot currents did not exceed current standard levels and guidelines. We observed minor semen quality and hormonal differences between the groups, including a slightly higher mean follicle-stimulating hormone level for exposed operators (7.6 vs 5.8 mIU/mL). Further occupational studies of RF-exposed men may be warranted.

30.) J. K. Grayson. Radiation exposure, socioeconomic status, and brain tumor risk in the US Air Force: a nested case-control study. Am J Epidemiol. 1996. 143(5): 480-6.

A nested case-control study was used to investigate the relation between a range of electromagnetic field exposures and brain tumor risk in the US Air Force. Cumulative extremely low frequency and radiofrequency/microwave electromagnetic field potential exposures were estimated from a job-exposure matrix developed for this study. Ionizing radiation exposures were obtained from personal dosimetry records. Men who were exposed to nonionizing electromagnetic fields had a small excess risk for developing brain tumors, with the extremely low frequency and radiofrequency/microwave age-race-senior military rank- adjusted odds ratios being 1.28 (95% confidence interval (CI) 0.95-1.74) and 1.39 (95% CI 1.01-1.90), respectively. By contrast, men who were exposed to ionizing radiation had an age-race-senior military rank- adjusted odds ratio of 0.58 (95% CI 0.22-1.52). These results support a small association between extremely low frequency and radiofrequency/microwave electromagnetic field exposure and no association between ionizing radiation exposure and brain tumors in the US Air Force population. Military rank was consistently associated with brain tumor risk. Officers were more likely than enlisted men to develop brain tumors (age-race-adjusted odds ratio (OR) = 2.11, 95% CI 1.48-3.01), and senior officers were at increased risk compared with all other US Air Force members (age-race-adjusted OR = 3.30, 95% CI 1.99-5.45).

31.) E. Guberan, A. Campana, P. Faval, M. Guberan, P. M. Sweetnam, J. W. Tuyn and M. Usel. Gender ratio of offspring and exposure to shortwave radiation among female physiotherapists. Scand J Work Environ Health. 1994. 20(5): 345-8.

OBJECTIVES--The goal of this study was to investigate whether the deficit of male births found among the offspring of Danish physiotherapists exposed to shortwave radiation during the first month of their pregnancy could be confirmed among the offspring of physiotherapists from Switzerland. METHODS--A self-administrated questionnaire was mailed (two mailings) to all of the 2846 female members of the Swiss Federation of Physiotherapists. It included questions on the gender and birth-weight of all children of the physiotherapists, as well as on the use of shortwave or microwave equipment during the first month of each pregnancy. The response rate was 79.5%, and the analysis was based on 1781 pregnancies. RESULTS--The gender ratio (the number of males per number of females x 100) was 107 with a 95% confidence interval (95% CI) of 89-127 for the 508 pregnancies exposed to shortwave radiation and 101 (95% CI 90-113) for the 1273 unexposed pregnancies. There was no trend in the gender ratio with increasing intensity or duration of exposure. The prevalence of low birthweight (< or = 2500 g) was not related to exposure to shortwave radiation for either the boys or the girls. CONCLUSIONS--No atypical gender ratio was found for the children of female physiotherapists from Switzerland who had been exposed to shortwave radiation at the beginning of pregnancy. The findings of the Danish study could not be confirmed.

32.) L. A. Habel, J. L. Stanford, T. L. Vaughan, M. A. Rossing, L. F. Voigt, N. S. Weiss and J. R. Daling. Occupation and breast cancer risk in middle-aged women. J Occup Environ Med. 1995. 37(3): 349-56.

The authors analyzed data from a population-based case-control study of breast cancer in middle-aged women residing in King County, Washington, to examine the relation between occupation and breast cancer risk. A total of 537 cases and 492 controls completed in-person interviews. Subjects provided job titles and years of employment for their three main occupations since age 18. While there were case-control differences in the frequency with which certain jobs were reported, all were within the limits of chance, given no true association. Also, few additional increases in risk were associated with long-term employment. Relative risk (RR) estimates were elevated for women working in precision textile and apparel jobs (six cases and one control, RR = 5.2). To a lesser extent, RR estimates were also elevated for receptionists, cosmetologists, and the category of painters/sculptors/printmakers. A slight increase in risk was associated with several occupations, including nursing and teaching.

33.) S. Hamburger, J. N. Logue and P. M. Silverman. Occupational exposure to non-ionizing radiation and an association with heart disease: an exploratory study. J Chronic Dis. 1983. 36(11): 791-802.

Exploratory analyses for dose-related exposure to non-ionizing radiation and adverse health effects among male physical therapists were done from a mail questionnaire survey. The cohort consisted of 3004 respondents who were stratified into subgroups according to exposure across and within the various types of non-ionizing radiation energy emitted from diathermy equipment. The radiation modalities considered were ultrasound, microwave, shortwave, and infrared. An association between heart disease and exposure to shortwave radiation was the only consistently significant finding when high and low exposure groups were compared.

34.) L. Hardell, A. Nasman, C. G. Ohlson and M. Fredrikson. Case-control study on risk factors for testicular cancer. Int J Oncol. 1998. 13(6): 1299-303.

Occupational exposures were assessed in a case-control study on testicular cancer using self administered questionnaires. Answers were obtained for 148 (91%) cases and 314 (87%) controls. Of the cases 101 had seminoma and 47 had embryonal testicular cancer. Occupational plastics work yielded odds ratio (OR) 2.9 with 95% confidence interval (CI) 1.3-6.5. Increased risk was found for embryonal cancer regarding farming (OR 3.1; CI 1.03-9.1) and contact with farm animals (OR 3.3; CI 1.00-10.9), but not for seminoma. For all testicular cancer exposure to insects repellents, mostly containing N,N-diethyl-m-toluamide (DEET) gave OR 1.7; CI 1.03-2.8, with a dose-response effect. Somewhat increased risks were found for amateur radio operators (OR 2.2; CI 0.7- 6.6), work with radar equipment (OR 2.0; CI 0.3-14.2) and engineers in electronics and telecommunication industry (OR 2.3; CI 0.8-6.7) based on few exposed subjects, however. Video display unit work gave OR 1.5; CI 0.98-2.3 and for exposure 480 working days (median number) the risk increased further to OR 1.8; CI 1.1-3.2. Because of low numbers of exposed subjects in some calculations some of these results might be spurious and need to be further studied.

35.) L. Hardell, A. Nasman, A. Pahlson, A. Hallquist and K. Hansson Mild. Use of cellular telephones and the risk for brain tumours: A case- control study. Int J Oncol. 1999. 15(1): 113-6.

The use of cellular telephones has increased dramatically during the 1990's in the world. In the 1980's the analogue NMT system was used whereas the digital GSM system was introduced in early 1990's and is now the preferred system. Case reports of brain tumours in users initiated this case-control study on brain tumours and use of cellular telephones. Also other exposures were assessed. All cases, both males and females, with histopathologically verified brain tumour living in Uppsala-Orebro region (1994-96) and Stockholm region (1995-96) aged 20- 80 at the time of diagnosis and alive at start of the study were included, 233 in total. Two controls to each case were selected from the Swedish Population Register matched for sex, age and study region. Exposure was assessed by questionnaires supplemented over the phone. The analyses were based on answers from 209 (90%) cases and 425 (91%) controls. Use of cellular telephone gave odds ratio (OR) = 0.98 with 95% confidence interval (CI) = 0. 69-1.41. For the digital GSM system OR = 0.97, CI = 0.61-1.56 and for the analogue NMT system OR = 0.94, CI = 0.62-1.44 were calculated. Dose-response analysis and using different tumour induction periods gave similar results. Non-significantly increased risk was found for tumour in the temporal or occipital lobe on the same side as a cellular phone had been used, right side OR = 2.45, CI = 0.78-7.76, left side OR = 2.40, CI = 0.52-10.9 Increased risk was found only for use of the NMT system. For GSM use the observation time is still too short for definite conclusions. An increased risk for brain tumour in the anatomical area close to the use of a cellular telephone should be especially studied in the future.

36.) L. Hardell, A. Nasman, A. Pahlson and A. Hallquist. Case-control study on radiology work, medical x-ray investigations, and use of cellular telephones as risk factors for brain tumors. MedGenMed. 2000. E2.

CONTEXT: Ionizing radiation is a well-established risk factor for brain tumors. During recent years, microwave exposure from the use of cellular telephones has been discussed as a potential risk factor. OBJECTIVE: To determine risk factors for brain tumors. DESIGN: A case- control study, with exposure assessed by questionnaires. PARTICIPANTS: A total of 233 currently living men and women, aged 20 to 80 years, were included. The case patients had histopathologically verified brain tumors and lived in the Uppsala-Orebro region (1994-1996) or the Stockholm region (1995-1996). Two matched controls to each case were selected from the Swedish Population Register. MAIN OUTCOME MEASURES: Ionizing radiation and use of cellular telephones as risk factors for brain tumors. RESULTS: A total of 209 cases (90%) and 425 controls (91%) answered the questionnaire. Work as a physician yielded an odds ratio (OR) of 6.00, with a 95% confidence interval (CI) of 0.62 to 57.7. All three case patients had worked with fluoroscopy. Radiotherapy of the head and neck region yielded an OR of 3.61 (95% CI, 0.65-19.9). Medical diagnostic x-ray examination of the same area yielded an OR of 2.10 (95% CI, 1.25-3.53), with a tumor induction period of 5 years or more. Chemical industry work yielded an OR of 4.10 (95% CI, 1.25-13.4), and laboratory work yielded an OR of 3.21 (95% CI, 1.16-8.85). Ipsilateral use of cellular telephones increased the risk for tumors in the temporal, temporoparietal, and occipital lobes (OR, 2.42; 95% CI, 0.97-6.05), ie, the anatomic areas with highest exposure to microwaves from a mobile telephone. The result was further strengthened (OR, 2.62; 95% CI, 1.02-6.71) in a multivariate analysis that included laboratory work and medical diagnostic x-ray investigations of the head and neck. CONCLUSION: Exposure to ionizing radiation, work in laboratories, and work in the chemical industry increased the risk of brain tumors. Use of a cellular telephone was associated with an increased risk in the anatomic area with highest exposure.

37.) R. B. Hayes, L. M. Brown, L. M. Pottern, M. Gomez, J. W. Kardaun, R. N. Hoover, K. J. O'Connell, R. E. Sutzman and N. Javadpour. Occupation and risk for testicular cancer: a case-control study. Int J Epidemiol. 1990. 19(4): 825-31.

A case-control study of 271 testicular cancer cases aged 18-42, including 60 seminomas and 206 other germinal cell tumours, and 259 controls was carried out to study the association between occupation and testicular cancer risk. Study subjects were identified at three medical centres, two of which treat military personnel. Controls were men diagnosed with a cancer other than of the genital tract. Associations were identified between professional employment (administrators, teachers and other professionals) and risk for testicular seminoma, OR = 2.8 (95% CI: 1.4-5.4) and between employment in production work and risk for other germinal cell tumours, OR = 1.8 (95% CI: 1.1-2.7). No specific occupations within these broad groups were responsible for observed increases. Self-reported exposure to microwave and other radio waves was associated with an excess risk for both seminomas and other germinal cell tumours. However, an assessment of radio wave exposure based on job title did not support this finding. Although testicular cancer has been increasing in recent decades among young males, occupational factors did not appear to account for a substantial proportion of testicular cancer occurrence in the population studied.

38.) E. F. Heineman, Y. T. Gao, M. Dosemeci and J. K. McLaughlin. Occupational risk factors for brain tumors among women in Shanghai, China. J Occup Environ Med. 1995. 37(3): 288-93.

The etiology of brain cancer is not well understood and few studies have evaluated occupational risk factors among women. We evaluated occupation and industry at time of diagnosis for 276 incident primary brain tumor cases among women in Shanghai, China, for the period 1980- 1984, identified through the Shanghai Cancer Registry. Standardized incidence ratios (SIRs) and their 95% confidence intervals (CIs) were calculated for all occupations and industries with at least three female cases. SIRs compared observed to expected numbers of cases, based on incidence rates for Shanghai and the number of women in each occupation and industry according to the 1982 census. Statistically significant excesses of brain tumors were seen among grain farmers (SIR = 6.5, 95% CI = 1.3-19.1), rubber workers (SIR = 5.0, 95% CI = 1.6- 11.6), and workers in transportation equipment manufacture and repair (SIR = 2.3, 95% CI = 1.1-4.3). Risks among textile spinners and winders were of borderline significance (SIR = 1.7, 95% CI = 1.0-2.8). Elevated but nonsignificant risks of 2.0 or greater were seen among nurses, plastic products workers, sanitation workers, painters, and workers in manufacture of equipment for electrical generation, transmission, and distribution. Results for farmers, rubber workers, and painters are consistent with previously reported excesses among these occupations in men. The increase among nurses is a new finding, although elevated risks have been observed among male medical professionals. Risks were elevated with likely exposure to pesticides, particularly among those thought to have a high probability and a high level of exposure (SIR = 3.6, 95% CI = 1.2-8.5).

39.) B. Hocking, I. R. Gordon, H. L. Grain and G. E. Hatfield. Cancer incidence and mortality and proximity to TV towers. Med J Aust. 1996. 165(11-12): 601-5.

OBJECTIVE: To determine whether there is an increased cancer incidence and mortality in populations exposed to radiofrequency radiations from TV towers. DESIGN: An ecological study comparing cancer incidence and mortality, 1972-1990, in nine municipalities, three of which surround the TV towers and six of which are further away from the towers. (TV radiofrequency radiation decreases with the square of the distance from the source.) Cancer incidence and mortality data were obtained from the then Commonwealth Department of Human Services and Health. Data on frequency, power, and period of broadcasting for the three TV towers were obtained from the Commonwealth Department of Communications and the Arts. The calculated power density of the radiofrequency radiation in the exposed area ranged from 8.0 microW/cm2 near the towers to 0.2 microW/cm2 at a radius of 4km and 0.02 microW/cm2 at 12 km. SETTING: Northern Sydney, where three TV towers have been broadcasting since 1956. OUTCOME MEASURES: Rate ratios for leukaemia and brain tumour incidence and mortality, comparing the inner with the outer areas. RESULTS: For all ages, the rate ratio for total leukaemia incidence was 1.24 (95% confidence interval [CI], 1.09-1.40). Among children, the rate ratio for leukaemia incidence was 1.58 (95% CI, 1.07-2.34) and for mortality it was 2.32 (95% CI, 1.35-4.01). The rate ratio for childhood lymphatic leukaemia (the most common type) was 1.55 (95% CI, 1.00-2.41) for incidence and 2.74 (95% CI, 1.42-5.27) for mortality. Brain cancer incidence and mortality were not increased. CONCLUSION: We found an association between increased childhood leukaemia incidence and mortality and proximity to TV towers.

40.) P. D. Inskip, R. E. Tarone, E. E. Hatch, T. C. Wilcosky, W. R. Shapiro, R. G. Selker, H. A. Fine, P. M. Black, J. S. Loeffler and M. S. Linet. Cellular-telephone use and brain tumors. N Engl J Med. 2001. 344(2): 79-86.

BACKGROUND: Concern has arisen that the use of hand-held cellular telephones might cause brain tumors. If such a risk does exist, the matter would be of considerable public health importance, given the rapid increase worldwide in the use of these devices. METHODS: We examined the use of cellular telephones in a case-control study of intracranial tumors of the nervous system conducted between 1994 and 1998. We enrolled 782 patients through hospitals in Phoenix, Arizona; Boston; and Pittsburgh; 489 had histologically confirmed glioma, 197 had meningioma, and 96 had acoustic neuroma. The 799 controls were patients admitted to the same hospitals as the patients with brain tumors for a variety of nonmalignant conditions. RESULTS: As compared with never, or very rarely, having used a cellular telephone, the relative risks associated with a cumulative use of a cellular telephone for more than 100 hours were 0.9 for glioma (95 percent confidence interval, 0.5 to 1.6), 0.7 for meningioma (95 percent confidence interval, 0.3 to 1.7), 1.4 for acoustic neuroma (95 percent confidence interval, 0.6 to 3.5), and 1.0 for all types of tumors combined (95 percent confidence interval, 0.6 to 1.5). There was no evidence that the risks were higher among persons who used cellular telephones for 60 or more minutes per day or regularly for five or more years. Tumors did not occur disproportionately often on the side of head on which the telephone was typically used. CONCLUSIONS: These data do not support the hypothesis that the recent use of hand-held cellular telephones causes brain tumors, but they are not sufficient to evaluate the risks among long-term, heavy users and for potentially long induction periods.

41.) C. Johansen, M. Bitsch and S. Bulow. Fertility and pregnancy in women with familial adenomatous polyposis. Int J Colorectal Dis. 1990. 5(4): 203-6.

A questionnaire study was carried out among 58 Danish women with familial adenomatous polyposis concerning fertility, pregnancies, abortions and deliveries. Further data were obtained from obstetric records and general practitioners. The fertility and the course of the pregnancy of women with polyposis, frequency of miscarriages, legal abortions, mature and premature infants corresponds to the frequency among the obstetric population in Denmark. Of the 73 infants, eight (11%) were delivered by caesarean section. Of the 16 women who gave birth after an operation for familial adenomatous polyposis, 5 (31%) had a caesarean section. Of the seven infants who died, two had lethal congenital malformations and three infants were very premature.

42.) C. Johansen, J. D. Boice, Jr., J. K. McLaughlin, H. C. Christensen and J. H. Olsen. Mobile phones and malignant melanoma of the eye. Br J Cancer. 2002. 86(3): 348-9.

Recently a four-fold increase in the risk of malignant melanoma of the eye was associated with the use of radiofrequency transmitting devices, including mobile phones in Germany. We contrasted the incidence rates of this rare cancer with the number of mobile phone subscribers in Denmark. We observed no increasing trend in the incidence rate of melanoma, which was in sharp contrast to the exponentially increasing number of mobile phone subscribers starting in the early 1980s. Our study provides no support for an association between mobile phones and ocular melanoma.

43.) C. C. Johnson and M. R. Spitz. Childhood nervous system tumours: an assessment of risk associated with paternal occupations involving use, repair or manufacture of electrical and electronic equipment. Int J Epidemiol. 1989. 18(4): 756-62.

Parental occupational exposures to chemical carcinogens have been associated with malignancies in offspring. Recent studies have raised the issue that electromagnetic fields may play a role in carcinogenesis. We conducted a population-based case-control study testing for an association between the occurrence of a nervous system tumour in a child and paternal employment at the time of the child's birth in occupations involving potential exposure to low frequency electromagnetic fields, primarily in the electrical and electronics industries. Birth certificate data, including parental occupation information, of 499 children who died in Texas from intracranial and spinal cord tumours were compared with 998 controls randomly selected from Texas livebirths. The odds ratio for paternal employment in industries involving potential electromagnetic field exposure was 1.6 (p less than 0.07). A risk of 3.5 (p less than 0.05) was detected for fathers who were electricians. The additional presence of chemical exposures in these diverse occupations and industries must also be considered.

44.) A. G. Johnson Liakouris. Radiofrequency (RF) sickness in the Lilienfeld Study: an effect of modulated microwaves? Arch Environ Health. 1998. 53(3): 236-8.

There is a controversy among professionals regarding whether radiofrequency radiation sickness syndrome is a medical entity. In this study, this controversy was evaluated with a methodology adapted from case studies. The author reviewed U.S. literature, which revealed that research results are sufficiently consistent to warrant further inquiry. A review of statistically significant health effects noted in the Lilienfeld Study provided evidence that the disregarded health conditions match the cluster attributed to the radiofrequency sickness syndrome, thus establishing a possible correlation between health effects and chronic exposure to low-intensity, modulated microwave radiation. The author discusses these health effects relative to (a) exposure parameters recorded at the U.S. Embassy in Moscow and (b) the Soviet 10-microwatt safety standard for the public. Given the evidence, new research-with current knowledge and technology-is proposed.

45.) B. Kallen, G. Malmquist and U. Moritz. Delivery outcome among physiotherapists in Sweden: is non-ionizing radiation a fetal hazard? Arch Environ Health. 1982. 37(2): 81-5.

A cohort study was made on 2,043 infants born to 2,018 females registered as physiotherapists at the time of pregnancy during 1973 to 1978. The incidence of perinatal death, serious malformation, short gestational duration, and low birth weight was slightly below the expected with consideration given to maternal age and parity distribution. Information on occupational exposure (use of shortwave, microwave, and ultrasonic equipment, X-ray exposure, use of electrostimulator or hexachlorophene-containing soaps) was obtained in a case-control study within the cohort from mail questionnaires with a 93% response rate. The only positive finding was a higher incidence of shortwave equipment use among the females with a dead or malformed infant than among controls. Various explanations for this finding are discussed.

46.) E. Kanal, J. Gillen, J. A. Evans, D. A. Savitz and F. G. Shellock. Survey of reproductive health among female MR workers. Radiology. 1993. 187(2): 395-9.

Epidemiologic data were obtained to evaluate potential risks from exposure to the static and time-varying magnetic fields used in magnetic resonance (MR) imaging. A questionnaire sent to women workers in more than 90% of clinical MR facilities in the United States addressed menstrual-reproductive experiences, work activities, and potential confounders (eg, age, smoking, alcohol use). In 1,915 completed questionnaires, 1,421 pregnancies were reported: 280 occurred in an MR worker (technologist or nurse), 894 in an employee in another job, 54 in a student, and 193 in homemakers. Comparing MR-worker pregnancies with those occurring in employees at other jobs, a relative risk ratio of 1.27 (95% confidence interval [CI], 0.92-1.77) was found for spontaneous abortions; for conception taking more than 12 months, 0.90 (CI, 0.54-1.51); for delivery before 39 weeks, 1.19 (CI, 0.76- 1.88); for birth weight below 5.5 lb (2.5 kg), 1.01 (CI, 0.50-2.04); and for male gender of the offspring, 0.99 (CI, 0.80-1.22). Adjustment for maternal age, smoking, and alcohol use also failed to markedly change any of the associations. These results suggest that there is not a substantial increase in these common adverse reproductive outcomes.

47.) S. Kaplan, S. Etlin, I. Novikov and B. Modan. Occupational risks for the development of brain tumors. Am J Ind Med. 1997. 31(1): 15-20.

Occupationally related risk factors were assessed in a population- based, case-control study of 139 patients with primary brain tumors (BT), carried out in central Israel between 1987-1991. For each case, two control groups were matched by age (+/-5 years), sex, and ethnic origin. The interview schedule included questions about lifelong occupational history before diagnosis. Odds ratios (OR) for BT, according to industrial categories, showed a significantly increased risk among blue-collar workers, especially among those employed in the textile industry, and among drivers and motor vehicle operators. When histologic tumor types were assessed separately, a significantly increased risk for malignant BT was found among drivers and motor vehicle operator occupations, while for meningiomas, an increased risk was found among weavers and tailors. Our results may provide clues for etiology and prevention measures.

48.) B. Kolmodin-Hedman, K. Hansson Mild, M. Hagberg, E. Jonsson, M. C. Andersson and A. Eriksson. Health problems among operators of plastic welding machines and exposure to radiofrequency electromagnetic fields. Int Arch Occup Environ Health. 1988. 60(4): 243-7.

To study possible medical effects of high radiofrequency radiation (RF), 113 Swedish men and women were studied by means of a structured interview and rating of subjective symptoms. A test session was included in order to examine coordination and muscular function of the hands. A neurological test concerning two-point discrimination (2-PD) was also done. As referents, 23 women, sewing machine operators and assembly workers, were chosen, interviewed and likewise tested. Exposure measurements were taken of the RF fields around the welding machines. The present Swedish ceiling value of 250 W/m2 for the equivalent power density was exceeded in

more than 50% of the machines. The highest leakage fields, both for electric and magnetic fields, were found near machines used in factories for ready-made clothing, which gave a high exposure to the hands. Irritative eye symptoms were reported by 23% of the men and 40% of the women. A group of 27 persons was selected for a clinical eye examination and checked by photographs, and nine persons had modest conjunctivitis. A high prevalence of numbness in hands, especially among women, was found. A significantly impaired 2-PD was found in the exposed women as compared to the referent group. The pregnancy outcome for 305 female plastic welders during 1974-1984 did not show any significant differences with the Swedish average concerning malformation or prenatal mortality.

49.) A. A. Kolodynski and V. V. Kolodynska. Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia. Sci Total Environ. 1996. 180(1): 87-93.

This paper presents the results of experiments on school children living in the area of the Skrunda Radio Location Station (RLS) in Latvia. Motor function, memory and attention significantly differed between the exposed and control groups. Children living in front of the RLS had less developed memory and attention, their reaction time was slower and their neuromuscular apparatus endurance was decreased.

50.) R. R. Kuijten, G. R. Bunin, C. C. Nass and A. T. Meadows. Parental occupation and childhood astrocytoma: results of a case- control study. Cancer Res. 1992. 52(4): 782-6.

Parental occupations were investigated as possible risk factors for astrocytoma, the most frequently occurring brain tumor in children. A case-control study of 163 pairs was performed. Cases under 15 years of age at diagnosis in 1980-1986 were identified through the tumor registries of eight hospitals in Pennsylvania, New Jersey, and Delaware. Controls were selected by random-digit dialing and were matched to cases on age, race, and telephone area code. Occupations before the child's conception, during the pregnancy, and after the child's birth were studied separately. We did not observe any strong associations. Significantly more fathers of cases were electrical or electronic repairmen, a subgroup of an occupational category previously associated with increased risk. An excess of case mothers employed as nurses was observed, which was significant for mothers of children diagnosed before 5 years of age. Elevated although not significant odds ratios were observed for some white collar and professional occupations in case parents; for paternal exposure to paint and paternal occupation in the paper and pulp mill industry, both in the period after the child's birth; and for maternal occupation as a hairdresser. The lack of strong associations may have resulted from low statistical power for some job groupings. Our study, unlike previous studies, focused on a single type of brain tumor: childhood astrocytoma. Thus our results suggest that some parental occupations associated with childhood brain tumors in previous studies may not be risk factors for childhood astrocytoma.

51.) K. Kurppa, P. C. Holmberg, K. Rantala, T. Nurminen and L. Saxen. Birth defects and exposure to video display terminals during pregnancy. A Finnish case-referent study. Scand J Work Environ Health. 1985. 11(5): 353-6.

In a test of the widely publicized allegation that exposure to video display terminals causes birth defects, interview forms of mothers of 1 475 children reported consecutively to the Finnish Register of Congenital Malformations to have defects of the central nervous system, orofacial clefts, skeletal defects, or cardiovascular malformations and the forms of the same number of their paired referents were studied. The scrutiny revealed 490 mothers with occupational titles indicating potential exposure to video display terminals. Of the 490, 235 were case mothers and 255 were referents. Then, unaware of the case-referent status, three members of the research team perused the mothers' interview descriptions of workday activities for information indicating exposure to video display terminals. Work with such terminals during the first trimester of pregnancy was ascertained for 111 mothers. Of these, 51 were case mothers and 60 were referents. The comparison of the mothers exposed to video display terminals during the first trimester with those not exposed at all showed a crude odds-ratio point estimate of 0.9 with 95% confidence limits of 0.6 and 1.2. Adjustment for potential confounders by multivariate logistic regression methods did not materially affect the risk estimates. The results did not indicate a teratogenic risk for operators of video display terminals.

52.) S. Lagorio, S. Rossi, P. Vecchia, M. De Santis, L. Bastianini, M. Fusilli, A. Ferrucci, E. Desideri and P. Comba. Mortality of plastic-ware workers exposed to radiofrequencies. Bioelectromagnetics. 1997. 18(6): 418-21.

The mortality experience of a cohort of Italian plastic-ware workers exposed to radiofrequency (RF)-electromagnetic fields generated by dielectric heat sealers was investigated. Follow-up extended from 1962 to 1992. The standardised mortality ratio (SMR) analysis was restricted to 481 women workers, representing 78% of the total person-years at risk. Mortality from malignant neoplasms was slightly elevated, and increased risks of leukemia and accidents were detected. The all-cancer SMR was higher among women employed in the sealing department, where exposure to RF occurred, than in the whole cohort. This study raises interest in a possible association between exposure to RF radiation and cancer risk. However, the study power was very small, and the possible confounding effects of exposure to solvents and vinyl chloride monomer (VCM) could not be ruled out. The hypothesis of an increased risk of cancer after radiofrequency exposure should be further explored by means of analytical studies characterised by adequate power and more accurate exposure assessment.

53.) A. I. Larsen, J. Olsen and O. Svane. Gender-specific reproductive outcome and exposure to high-frequency electromagnetic radiation among physiotherapists. Scand J Work Environ Health. 1991. 17(5): 324-9.

The aim of this case-referent study was to investigate reproductive hazards other than congenital malformations after exposure to high- frequency electromagnetic radiation. Cases and referents were sampled from a cohort of pregnancies of members of the Union of Danish Physiotherapists through linkage of the union file with national medical registers. Case groups were spontaneous abortions and children with low birth-weight prematurity, and stillbirth/death within one year. Exposure to high-frequency electromagnetic radiation before and during pregnancy was assessed through telephone interviews. As referents to the 270 cases, 316 pregnancies were randomly sampled. A total of 8.4% did not participate. Only 23.5% of the children born by the highly exposed

mothers were boys. This value is a statistically significantly altered gender ratio showing a dose-response pattern. High-frequency electromagnetic radiation was furthermore associated with low birthweight, but only for male newborns. The other outcomes were not statistically significantly associated with exposure to high- frequency electromagnetic radiation.

54.) A. I. Larsen. Congenital malformations and exposure to high-frequency electromagnetic radiation among Danish physiotherapists. Scand J Work Environ Health. 1991. 17(5): 318-23.

A cluster initiated the present case-referent study to assess the relation between exposure to high-frequency electromagnetic radiation and congenital malformations. Through the linkage of a cohort formed from a union file of Danish physiotherapists with complete national registers of pregnancy outcome, cases (pregnancies terminated by the birth of a malformed child) and referents were identified. From responses in a blinded telephone interview without knowledge of case status, exposure to high-frequency electromagnetic radiation in the first month of pregnancy was assessed. Indices reflecting duration of exposure ("time") and maximum level of exposure ("peak") were composed. After a 7% dropout 54 cases and 247 referents were interviewed. No statistically significant associations between pregnancy outcome and high-frequency electromagnetic radiation were found (odds ratio 1.7, 95% confidence interval 0.6-4.3).

55.) Y. Lerman, R. Jacubovich and M. S. Green. Pregnancy outcome following exposure to shortwaves among female physiotherapists in Israel. Am J Ind Med. 2001. 39(5): 499-504.

BACKGROUND: The findings of the few epidemiological studies on the possible association between shortwave diathermy use by pregnant physiotherapists and adverse pregnancy outcome are inconsistent. We investigated such an association among physiotherapists in Israel. METHODS: Individualized data on exposure to shortwaves, ultrasound, and heavy lifting were collected by questionnaires and telephone interviews. RESULTS: The 434 studied women included 930 pregnancies: 175 ended in spontaneous abortions, 45 had fetal malformations, 47 were delivered prematurely, and 33 infants had low birth weight. The remaining 630 normal pregnancies comprised the control group. Univariate analysis showed that exposure to shortwaves was associated with a significantly increased odds ratio (O.R.) for congenital malformations (O.R. 2.24, CI 1.27-4.83, P =.006) and low birth weight (O.R. 2.99, CI 1.32-6,79, P =.006). This effect increased in a dose- related manner. After controlling for potential confounding variables, only low birth weight reached statistical significance (O.R. 2.75, CI 1.07-7.04, P =.03). From the potentially confounding variables tested, febrile disease during pregnancy was found to be significantly associated with low birth weight (O.R. 3.37, CI 1.38-8.25, P =.01). CONCLUSIONS: The findings of our study suggest that shortwaves have potentially harmful effects on pregnancy outcome, specifically low birth weight.

56.) R. S. Lin, P. C. Dischinger, J. Conde and K. P. Farrell. Occupational exposure to electromagnetic fields and the occurrence of brain tumors. An analysis of possible associations. J Occup Med. 1985. 27(6): 413-9.

To explore the association between occupation and the occurrence of brain tumor, an epidemiologic study was conducted using data from the death certificates of 951 adult white male Maryland residents who died of brain tumor during the period 1969 through 1982. Compared with the controls, men employed in electricity-related occupations, such as electrician, electric or electronic engineer, and utility company serviceman, were found to experience a significantly higher proportion of primary brain tumors. An increase in the odds ratio for brain tumor was found to be positively related to electromagnetic (EM) field exposure levels. Furthermore, the mean age at death was found to be significantly younger among cases in the presumed high EM-exposure group. These findings suggest that EM exposure may be associated with the pathogenesis of brain tumors, particularly in the promoting stage.

57.) M. S. Linet, H. S. Malker, J. K. McLaughlin, J. A. Weiner, B. J. Stone, W. J. Blot, J. L. Ericsson and J. F. Fraumeni, Jr. Leukemias and occupation in Sweden: a registry-based analysis. Am J Ind Med. 1988. 14(3): 319-30.

A linked-registry was used to examine systematically, on a national basis, the leukemia incidence in Swedish men by industry and occupation. New associations were observed for chronic lymphocytic leukemia among cloth and pattern cutters and for chronic myelocytic leukemia among brewery workers and motor mechanics. A number of additional findings were consistent with previous observations in other countries. Although etiologic inferences are limited when using linked- registry data, this hypothesis-generating study may provide new clues to the occupational determinants of specific forms of leukemia.

58.) A. A. Marino. Time-dependent hematological changes in workers exposed to electromagnetic fields. Am Ind Hyg Assoc J. 1995. 56(2): 189-92.

A World War II-era study, involving the effects of electromagnetic fields (EMFs) emanating from radars and high-frequency radios on the blood of exposed workers, was analyzed for evidence of the effect of time in the manifestation of changes in the hematological system. Statistically significant correlations between increasing white blood cell count and average daily exposure, months of exposure, and total duration of exposure to EMFs were found. Changes in cell count were within the normal range, and thus their relation to epidemiological studies linking EMFs and leukemia, if any, is unclear. Results suggest that the time of exposure may be an additional factor (along with field strength, and perhaps frequency) in ascertaining the safety of EMF exposure.

59.) G. Maskarinec, J. Cooper and L. Swygert. Investigation of increased incidence in childhood leukemia near radio towers in Hawaii: preliminary observations. J Environ Pathol Toxicol Oncol. 1994. 13(1): 33-7.

Twelve children from the Waianae Coast, Hawaii, were diagnosed with acute leukemia from 1979 to 1990. The standardized incidence ratio (SIR) of 2.09 (95% confidence interval (CI) 1.08 to 3.65) indicates a significant increase. Seven cases occurred between 1982 and 1984 and were unusual in terms of sex, age, and type of leukemia. A case-control study (12 cases, 48 matched controls) explored risk factors, including

parents' occupation, X-ray exposure, domestic smoking, family and medical histories, and distance of children's residence locations to low frequency radio towers. The odds ratio (OR) for having lived within 2.6 miles of the radio towers before diagnosis was 2.0 (95% CI 0.06 to 8.3). The clustering may have been a chance event, but because of its peculiar characteristics, we feel it should be noted.

60.) A. D. McDonald, N. M. Cherry, C. Delorme and J. C. McDonald. Visual display units and pregnancy: evidence from the Montreal survey. J Occup Med. 1986. 28(12): 1226-31.

Data on 56,012 current and 48,608 previous pregnancies were obtained by interview in 11 Montreal hospitals, 1982 to 1984, after delivery or spontaneous abortion. In 17,632 pregnancies in occupations with substantial use of visual display units (VDUs), users and nonusers had similar rates of congenital defects in both current and previous pregnancies and of abortions in previous pregnancies. In current pregnancies there was an excess of abortions in users which could have been due to biased recall. In a further analysis of all 42 occupational groups ranked according to percentage use of VDUs, the risk of spontaneous abortion in both current and previous pregnancies was the same irrespective of the amount of VDU use. Thus, the study does not support the suggestion that work with a VDU in pregnancy increases the risk of congenital defect or spontaneous abortion.

61.) A. D. McDonald, J. C. McDonald, B. Armstrong, N. Cherry, A. D. Nolin and D. Robert. Work with visual display units in pregnancy. Br J Ind Med. 1988. 45(8): 509-15.

Data from the Montreal survey on occupational factors in pregnancy were used to test the hypothesis that visual display units (VDUs) constitute a hazard to reproduction. Use of a VDU was recorded in 4712 current and 2164 previous pregnancies of women in full time employment at time of conception. After allowance for seven confounding variables, the risk of spontaneous abortion in current pregnancies relative to all working women was 1.19 (90% CI 1.09-1.30) and in previous pregnancies, 0.97. In an analysis by occupational title, in which 60 occupational groups were aggregated into eight categories according to use of VDUs, the relative risk for spontaneous abortion was 1.06 (90% CI 0.8-1.4) in current pregnancies and 1.01 (90% CI 0.7-1.3) in previous pregnancies. This suggests that the small excess of spontaneous abortions among individual women reporting the use of VDUs in current pregnancies may have been due to recall bias. Relative risks for stillbirth, preterm birth, and low birth weight all had 90% confidence limits which included unity. In an analysis of congenital defects the number of pregnancies was increased to include women who worked 15 or more hours a week. In all but one of nine groups of congenital defect examined confidence limits for the relative risk included unity in both current and previous pregnancies. The relative risks for the renal urinary group of defects were raised in both current (1.84, 90% CI 1.07-3.15) and previous pregnancies (1.66, 90% CI 0.82-3.25). There being no prior reason to suspect a causal link with this type of defect, interpretation remains open to question.

62.) D. R. McKenzie, Y. Yin and S. Morrell. Childhood incidence of acute lymphoblastic leukaemia and exposure to broadcast radiation in Sydney--a second look. Aust N Z J Public Health. 1998. 22(3(Suppl)): 360-7.

INTRODUCTION: Recent findings of an apparent association between incidence of childhood leukaemia and radio frequency radiation (RFR) from television transmission antennas in Sydney, NSW, are examined. METHODS: Incidence of childhood (0-14 years) acute lymphoblastic leukaemia (ALL) at the local government area (LGA) level is related to estimated exposure levels of RFR from television transmission antennas, using Poisson regression techniques. RESULTS: Most of the association between ALL incidence and television transmission RFR is shown to be the result of an influential observation: one of the highly exposed LGAs contributes all the excess, while in a similarly exposed LGA childhood ALL incidence was found to be no higher than the rate expected for NSW. With the influential observation excluded from the analysis, no positive correlation between exposure to RFR and leukaemia is evident. Conversely, under the assumption of an association with RFR, the low probability of the observed incident cases in LGAs under conditions of relatively high exposure to RFR conflicts with the assumption of an effect. CONCLUSION: The apparent association between childhood ALL incidence and RFR radiation from television towers is weaker when an LGA-level analysis is conducted.

63.) S. Milham, Jr. Mortality in workers exposed to electromagnetic fields. Environ Health Perspect. 1985. 62: 297-300.

In an occupational mortality analysis of 486,000 adult male death records filed in Washington State in the years 1950-1982, leukemia and the non-Hodgkin's lymphomas show increased proportionate mortality ratios (PMRs) in workers employed in occupations with intuitive exposures to electromagnetic fields. Nine occupations of 219 were considered to have electric or magnetic field exposures. These were: electrical and electronic technicians, radio and telegraph operators, radio and television repairmen, telephone and power linemen, power station operators, welders, aluminum reduction workers, motion picture projectionists and electricians. There were 12,714 total deaths in these occupations. Eight of the nine occupations had PMR increases for leukemia [International Classification of Diseases (ICD), seventh revision 204] and seven of the nine occupations had PMR increases for the other lymphoma category (7th ICD 200.2, 202). The highest PMRs were seen for acute leukemia: (67 deaths observed, 41 deaths expected; PMR 162), and in the other lymphomas (51 deaths observed, 31 deaths expected; PMR 164). No increase in mortality was seen for Hodgkin's disease or multiple myeloma. These findings offer some support for the hypothesis that electric and magnetic fields may be carcinogenic.

64.) S. Milham, Jr. Increased mortality in amateur radio operators due to lymphatic and hematopoietic malignancies. Am J Epidemiol. 1988. 127(1): 50-4.

To search for potentially carcinogenic effects of electromagnetic field exposures, the author conducted a population-based study of mortality in US amateur radio operators. Ascertainment of Washington State and California amateur radio operators (67,829 persons) was done through the 1984 US Federal Communications Commission Amateur Radio Station and/or Operator License file. A total of 2,485 deaths were located for the period from January 1, 1979 through December 31, 1984, in a population of amateur radio operators which accumulated 232,499 person- years at risk. The all-cause standardized mortality ratio (SMR) was 71, but a statistically significant increased

mortality was seen for cancers of the other lymphatic tissues (SMR = 162), a rubric which includes multiple myeloma and non-Hodgkin's lymphomas. The all-leukemia standardized mortality ratio was slightly, but nonsignificantly, elevated (SMR = 124). However, mortality due to acute myeloid leukemia was significantly elevated (SMR = 176).

65.) R. W. Morgan, M. A. Kelsh, K. Zhao, K. A. Exuzides, S. Heringer and W. Negrete. Radiofrequency exposure and mortality from cancer of the brain and lymphatic/hematopoietic systems. Epidemiology. 2000. 11(2): 118-27.

The proliferation of wireless communication technologies has raised public concern regarding potential health effects of radiofrequency (RF) exposures. This is the first report of findings from a large- cohort mortality study among employees of Motorola, a manufacturer of wireless communication products. We examined all major causes of mortality, with brain cancers, lymphomas, and leukemias as a priori outcomes of interest. Using job titles, we classified workers into high, moderate, low, and background RF exposure groups. A total of 195,775 workers contributed 2.7 million person-years during the 1976- 1996 period. Using external comparisons, the standardized mortality ratios for RF-exposed workers were 0.53 [95% confidence interval (CI) = 0.21-1.09] and 0.54 (95% CI = 0.33-0.83) for central nervous system/brain cancers and all lymphomas/leukemias. Rate ratios calculated from Poisson regression models based on internal comparisons were near 1.0 for brain cancers and below 1.0 for all lymphomas and leukemias. These findings were consistent across cumulative, peak, and usual exposure classifications. We did not observe higher risk with increased exposure duration or latency. Although this study is limited by the use of a qualitative exposure matrix and the relatively young age of the cohort, our findings do not support an association between occupational RF exposure and brain cancers or lymphoma/leukemia.

66.) J. M. Muhm. Mortality investigation of workers in an electromagnetic pulse test program. J Occup Med. 1992. 34(3): 287-92.

A standardized mortality ratio study of 304 male employees of an electromagnetic pulse (EMP) test program was conducted. Outcomes were ascertained by two methods: the World Health Organization's underlying cause of death algorithm; and the National Center for Health Statistics' algorithm to identify multiple listed causes of death. In the 3362 person-years of follow-up, there was one underlying cause of death due to leukemia compared with with 0.2 expected (standard mortality ratio [SMR] = 437, 95% confidence interval [CI] = 11-2433), and two multiple listed causes of death due to leukemia compared with 0.3 expected (SMR = 775, 95% CI = 94-2801). Although the study suggested an association between death due to leukemia and employment in the EMP test program, firm conclusions could not be drawn because of limitations of the study. The findings warrant further investigation in an independent cohort.

67.) P. C. Nasca, M. S. Baptiste, P. A. MacCubbin, B. B. Metzger, K. Carlton, P. Greenwald, V. W. Armbrustmacher, K. M. Earle and J. Waldman. An epidemiologic case-control study of central nervous system tumors in children and parental occupational exposures. Am J Epidemiol. 1988. 128(6): 1256-65.

A population-based case-control study was conducted with 338 patients less than 15 years of age who were diagnosed with a primary tumor of the central nervous system from January 1968 through December 1977 in 53 contiguous New York counties. The study also included 676 controls who were selected from the birth certificate files of the New York State Department of Health. Parental occupational exposures at the time of each child's birth and at the time of tumor diagnosis were derived from maternal interviews. The current data set failed to show any consistent association between childhood central nervous system tumor risk and paternal occupational exposures to hydrocarbons or to electromagnetic fields, or employment in the aerospace industry or pulp and paper manufacturing. Findings for occupational exposures to ionizing radiation were also inconsistent. A positive association was observed between central nervous system tumor risk and paternal exposures to ionizing radiation based on industrial codes. Odds ratios ranged from 1.71 to 2.15. This association was not observed when paternal occupational titles were used to define exposure (range of odds ratios, 1.01-1.10). Maternal exposures to ionizing radiation were not related to risk regardless of the classification scheme used.

68.) R. Nilsson, Y. Hamnerius, K. H. Mild, H. A. Hansson, E. Hjelmqvist, S. Olanders and L. I. Persson. Microwave effects on the central nervous system--a study of radar mechanics. Health Phys. 1989. 56(5): 777-9.

Seventeen radar mechanics and engineers and 12 unexposed referents were examined, using extensive neurological, psychometric and neuropsychiatric techniques to determine whether there were any indications of central nervous system effects of microwave exposure. Pathological neurological findings were not more common in the exposed group than among the referents. In addition, the psychometric tests and the psychiatric rating scales did not reveal any statistically significant adverse effects of microwave exposure. The frequency of the occurrence of an increased protein band with an isoelectric point of 4.5 in the cerebrospinal fluid was higher among the men exposed to microwaves than among the referents. The nature and clinical significance of this or these proteins are still unclear. The time derivative of the magnetic flux density close to some of the transmitter units was surprisingly high (up to 350 T s-1).

69.) T. Nurminen and K. Kurppa. Office employment, work with video display terminals, and course of pregnancy. Reference mothers' experience from a Finnish case-referent study of birth defects. Scand J Work Environ Health. 1988. 14(5): 293-8.

In an examination of the possible harmful effects of work in an office environment and the use of a video display terminal (VDT) on the course of pregnancy, the experience of 1,475 reference mothers from a Finnish case-referent study of birth defects was analyzed. The study was based on the national Register of Congenital Malformations, whose data were supplemented with special interviews on mothers' work conditions. The group which worked in an office environment consisted of 239 women, of whom 60 had worked with video display terminals; 805 mothers had not worked in an office. Only mothers who had worked during most of their pregnancy and who had a singleton birth were included; hence 431 women were excluded from the analysis. The information on threatened abortion, length of gestation, birthweight, placental weight, and maternal blood pressure was analyzed. Office work involved no elevated risk of threatened

abortion when compared with nonoffice work, and among the VDT users the proportion with symptoms related to an impending early termination of pregnancy was similar to that of other office workers. No unfavorable effects on the length of gestation were observed between the compared groups, and there were no differences in the birthweight of the babies when adjustment was made for gestational age or the other aspects under consideration. Thus the results did not suggest that office employment or work with video display terminals would be harmful for pregnancy.

70.) R. Ouellet-Hellstrom and W. F. Stewart. Miscarriages among female physical therapists who report using radio- and microwave-frequency electromagnetic radiation. Am J Epidemiol. 1993. 138(10): 775-86.

Physical therapists are exposed to radio- and microwave-frequency electromagnetic radiation by operating shortwave and microwave diathermy units. Recent studies suggest that use of shortwave diathermy is associated with an excess risk of birth defects, perinatal deaths, and late spontaneous abortions among the offspring of exposed female therapists. To assess the impact of occupational use of microwave and shortwave diathermy at the time of conception, the authors mailed questionnaires to 42,403 physical therapists in 1989. Both occupational and reproductive histories were obtained. Exposures to shortwave and microwave diathermy were both assessed in the same fashion and were examined in relation to early recognized fetal loss in a nested case- control design. A total of 1,753 case pregnancies (miscarriages) were matched to 1,753 incidence density control pregnancies (other pregnancies except ectopic pregnancies). A pregnancy was considered "exposed" if the mother reported using microwave or shortwave diathermy anytime during the 6 months prior to the first trimester or during the first trimester. Pregnancies of mothers reporting microwave use 6 months prior to the pregnancy or during the first trimester were more likely to result in miscarriage (odds ratio (OR) = 1.28, 95% confidence interval (CI) 1.02-1.59). The odds ratio increased with increasing level of exposure (chi 2 = 7.25, $p < 0.005$). The odds ratio in the highest exposure group (20 or more exposures/month) was 1.59. The overall odds ratio was slightly lower after it was controlled for prior fetal loss (OR = 1.26, 95% CI 1.00-1.59), but the exposure- response effect remained (chi 2 = 5.17, $p < 0.01$). The risk of miscarriage was not associated with reported use of shortwave diathermy equipment (OR = 1.07, 95% CI 0.91-1.24). The odds ratio in the highest exposure group was 0.87.

71.) N. Pearce, J. Reif and J. Fraser. Case-control studies of cancer in New Zealand electrical workers. Int J Epidemiol. 1989. 18(1): 55-9.

A series of reports, including a New Zealand case-control study, have suggested that electrical workers are at increased risk of leukaemia. We report here a further series of case-control studies based on the New Zealand Cancer Registry. These involved 19,904 male patients registered with cancer for the period 1980-1984 who were aged 20 years or more at time of registration. For each cancer site, the registrations for other sites formed the control group. Three main findings emerged. First, there is an elevated leukaemia risk in New Zealand electrical workers (odds ratio (OR) = 1.62, 95% confidence interval (CI) 1.04-2.52), but little evidence of increased risks for other cancer sites. Second, contrary to other published studies, the increased risk was primarily for chronic leukaemia (OR = 2.12) rather than acute leukaemia (OR = 1.25), and for lymphatic leukaemia (OR = 1.73) rather than myeloid leukaemia (OR = 1.22). Third, the

increased risk was strongest for certain categories of electrical work including radio and television repairers (OR = 7.86, 95% CI 2.20-28.09), electricians (OR = 1.68, 95% CI = 0.75-3.79), linemen (OR = 2.35, 95% CI 0.97-5.70) and power station operators (OR = 3.89, 95% CI 1.00- 15.22).

72.) J. S. Reif, N. Pearce and J. Fraser. Occupational risks for brain cancer: a New Zealand Cancer Registry- based study. J Occup Med. 1989. 31(10): 863-7.

Occupational risks for brain cancer were evaluated in a New Zealand Cancer Registry-based case-control study. The case subjects were 452 men aged 20 years or older registered under classifications 191 (Cancer of the brain) and 192 (Cancer of other and unspecified parts of the nervous system) of the International Classification of Disease (9th ed) from 1980 to 1984 for whom occupational information was available. The remaining 19,452 men with other cancers registered during an excess of professional and technical workers. An increased risk among workers in agriculture, forestry, and fishing was due to an excess of brain cancer in farmers, with the highest risk found for livestock farmers. Although many comparisons have been made, some of the findings support previous studies and several new hypotheses are suggested.

73.) E. Richter, T. Berman, E. Ben-Michael, R. Laster and J. B. Westin. Cancer in radar technicians exposed to radiofrequency/microwave radiation: sentinel episodes. Int J Occup Environ Health. 2000. 6(3): 187-93.

Controversy exists concerning the health risks from exposures to radiofrequency/microwave irradiation (RF/MW). The authors report exposure-effect relationships in sentinel patients and their co- workers, who were technicians with high levels of exposure to RF/MW radiation. Information about exposures of patients with sentinel tumors was obtained from interviews, medical records, and technical sources. One patient was a member of a cohort of 25 workers with six tumors. The authors estimated relative risks for cancer in this group and latency periods for a larger group of self-reported individuals. Index patients with melanoma of the eye, testicular cancer, nasopharyngioma, non- Hodgkin's lymphoma, and breast cancer were in the 20-37-year age group. Information about work conditions suggested prolonged exposures to high levels of RF/MW radiation that produced risks for the entire body. Clusters involved many different types of tumors. Latency periods were extremely brief in index patients and a larger self-reported group. The findings suggest that young persons exposed to high levels of RF/MW radiation for long periods in settings where preventive measures were lax were at increased risk for cancer. Very short latency periods suggest high risks from high-level exposures. Calculations derived from a linear model of dose-response suggest the need to prevent exposures in the range of 10-100 microw/cm(2).

74.) C. D. Robinette, C. Silverman and S. Jablon. Effects upon health of occupational exposure to microwave radiation (radar). Am J Epidemiol. 1980. 112(1): 39-53.

The effects of occupational experience with microwave radiation (radar) on the health of US enlisted Naval personnel were studied in cohorts of approximately 20,000 men with maximum opportunity for exposure (electronic equipment repair) and 208000 with minimum potential for exposure (equipment operation) who served during the Korean

War period. Potential exposure was assessed in terms of occupational duties, length of time in occupation and power of equipment at the time of exposure. Actual exposure to members of each cohort could not be established. Mortality by cause of death, hospitalization during military service, later hospitalization in Veterans Administration (VA) facilities, and VA disability compensation were the health indexes studied, largely through the use of automated record systems. No adverse effects were detected in these indexes that could be attributed to potential microwave radiation exposures during the period 1950-1954. Functional and behavioral changes and ill-defined conditions, such as have been reported as microwave effects, could not be investigated in this study but subgroups of the living study population can be identified for expanded follow-up.

75.) M. Sandstrom, J. Wilen, G. Oftedal and K. Hansson Mild. Mobile phone use and subjective symptoms. Comparison of symptoms experienced by users of analogue and digital mobile phones. Occup Med (Lond). 2001. 51(1): 25-35.

In 1995 many people reported symptoms such as headaches, feelings of discomfort, warmth behind/around or on the ear and difficulties concentrating while using mobile phones. The number of complaints was higher for people using the digital (GSM) system, i.e. with pulse modulated fields, than for those using the analogue (NMT) system. Our main hypothesis was that GSM users experience more symptoms than NMT users. An epidemiological investigation was initiated including 6379 GSM users and 5613 NMT 900 users in Sweden, and 2500 from each category in Norway. The adjusted odds ratio did not indicate any increased risk for symptoms for GSM users compared with NMT 900 users. Our hypothesis was therefore disproved. However, we observed a statistically significant lower risk for sensations of warmth on the ear for GSM users compared with NMT 900 users. The same trend was seen in Norway for sensations of warmth behind/around the ear and in Sweden for headaches and fatigue. Factors distinguishing the two systems (radio frequency emission, phone temperatures and various ergonomic factors) may be responsible for these results, as well as for a secondary finding: a statistically significant association between calling time/number of calls per day and the prevalence of warmth behind/around or on the ear, headaches and fatigue.

76.) B. Schlehofer, S. Kunze, W. Sachsenheimer, M. Blettner, D. Niehoff and J. Wahrendorf. Occupational risk factors for brain tumors: results from a population- based case-control study in Germany. Cancer Causes Control. 1990. 1(3): 209-15.

In a population-based case-control study in the Rhein-Neckar-Odenwald area (containing 1.3 million inhabitants) of the Federal Republic of Germany (FRG), risk factors were assessed for brain tumor development in 226 cases with primary brain tumors (ICD-9 191, 192.1, 192.0) and 418 population controls, interviewed by a standardized questionnaire. The analysis of occupational risk factors and smoking is presented. No elevated risk was found for smoking. Similarly, no significant effects were found for most occupations. Five specific occupational groups were examined because of a priori determination that they were of interest. Some categories showed slightly elevated risks but in none was the elevation statistically significant. A significant increase in risk for brain tumor development was found associated with working in electrical occupations for women (relative risk [RR] = 5.2; 95 percent confidence interval [CI] 1.4-20.1) but not for men (RR = 0.9, 95 percent CI 0.3- 2.3).

77.) T. M. Schnorr, B. A. Grajewski, R. W. Hornung, M. J. Thun, G. M. Egeland, W. E. Murray, D. L. Conover and W. E. Halperin. Video display terminals and the risk of spontaneous abortion. N Engl J Med. 1991. 324(11): 727-33.

BACKGROUND. The relation between spontaneous abortion and the use of video display terminals (VDTs) is of great public health concern. Previous investigators of this issue have reported inconsistent findings. METHODS. To determine whether electromagnetic fields emitted by VDTs are associated with an increased risk of spontaneous abortion, a cohort of female telephone operators who used VDTs at work was compared with a cohort of operators who did not use VDTs. To obtain reliable estimates of exposure, we determined the number of hours of VDT use per week from company records and measured electromagnetic fields at VDT workstations and, for purposes of comparison, at workstations without VDTs. Operators who used VDTs had higher abdominal exposure to very-low-frequency (15 kHz) electromagnetic fields (workstations without VDTs did not emit very-low-frequency energy). Abdominal exposure to extremely-low-frequency fields (45 to 60 Hz) was similar for both operators who used VDTs and those who did not. Among 2430 women interviewed, there were 882 pregnancies that met our criteria for inclusion in the study. RESULTS. We found no excess risk of spontaneous abortion among women who used VDTs during the first trimester of pregnancy (odds ratio = 0.93; 95 percent confidence interval, 0.63 to 1.38), and no dose-response relation was apparent when we examined the women's hours of VDT use per week (odds ratio for 1 to 25 hours per week = 1.04; 95 percent confidence interval, 0.61 to 1.79; odds ratio for greater than 25 hours per week = 1.00; 95 percent confidence interval, 0.61 to 1.64). There continued to be no risk associated with the use of VDTs when we accounted for multiple pregnancies, conducted separate analyses of early abortion, late abortion, and all fetal losses, or limited our analyses to spontaneous abortions for which a physician was consulted. CONCLUSIONS. The use of VDTs and exposure to the accompanying electromagnetic fields were not associated with an increased risk of spontaneous abortion in this study.

78.) S. M. Schrader, R. E. Langford, T. W. Turner, M. J. Breitenstein, J. C. Clark, B. L. Jenkins, D. O. Lundy, S. D. Simon and T. B. Weyandt. Reproductive function in relation to duty assignments among military personnel. Reprod Toxicol. 1998. 12(4): 465-8.

As a follow-up to the pilot study of semen quality of soldiers with various military assignments a larger, more complete study was conducted. Soldiers were recruited at Fort Hood, Texas. Thirty-three men were exposed to radar as part of their duty assignment in the Signal Corps, 57 men were involved with firing the 155 mm howitzer (potential lead exposure), and 103 soldiers had neither lead nor radar exposure and served as the comparison control group. Both serum and urinary follicle-stimulating hormone and luteinizing hormone and serum, salivary, and urine testosterone levels were determined in all men. A complete semen analysis was conducted on each soldier. For statistical analysis, the primary study variables were: sperm concentration, sperm/ejaculate, semen volume, percent normal morphology, percent motile, percent viable (both vital stain and hypoosmotic swelling), curvilinear velocity, straight-line velocity, linearity, sperm head length, width, area, and perimeter. Variables were adjusted for significant confounders (e.g., abstinence, sample age, race). No statistical differences ($P < 0.05$) were observed in any measurement. While these results are in

agreement with two previous studies assessing soldiers firing the 155-mm howitzer, they contradict our previous report indicating that radar exposure caused a significant decrease in sperm numbers. A possible explanation is that the radar exposure in this study was that used in Signal Corps operations while the men in the previous study were using different radar as part of military intelligence operations. The data presented here in men firing the 155-mm howitzer combined with the results from the previous studies confirms that there are no deficits in semen quality in these men. The contradiction between the results of the radar exposure studies indicates that more data are needed to evaluate the relationship of military radar and male reproductive health.

79.) D. E. Shacklett, T. J. Tredici and D. L. Epstein. Evaluation of possible microwave-induced lens changes in the United States Air Force. Aviat Space Environ Med. 1975. 46(11): 1403-6.

An Air Force examination team performed ophthalmologic examinations on 817 subjects in a double blind fashion. The subjects included 477 workers in the microwave radiation field and 340 control subjects with no known history of occupational exposure to microwave radiation. The intent of the study was to determine if a significant difference existed between the two groups for the presence of three lenticular findings equated with early cataract formation. No significant difference was found. Thus, this study does not support the contention that microwave exposure in the military environment is causing human cataracts at levels permitted by U.S. Safety Standards.

80.) E. M. Smith, M. Hammonds-Ehlers, M. K. Clark, H. L. Kirchner and L. Fuortes. Occupational exposures and risk of female infertility. J Occup Environ Med. 1997. 39(2): 138-47.

This study examined the association between occupational chemical and radiation exposures and risk of medically diagnosed infertility in 281 women compared with 216 fertile women. After adjustment for age and exposures that occurred before case/referent ascertainment, there was an increased risk of infertility among those women exposed to volatile organic solvents (odds ratio [OR], 1.74; 95% confidence interval [CI], 1.11 to 2.71), chemical dusts (OR, 2.66; CI, 1.17 to 6.05), pesticides (OR, 3.02; CI, 1.10 to 8.29), and video display terminals (OR, 2.21, CI, 1.22, to 4.01). Among the medically diagnosed causes of infertility, the adjusted risk associated with having an ovulatory factor increased among those women exposed to solvents (OR, 1.75; CI, 1.03 to 2.98), dusts (OR, 3.00; CI, 1.19 to 7.52), or pesticides (OR, 3.82; 1.28 to 11.42). Solvents and dusts also were associated with a higher risk of tubal-factor infertility (solvents; OR, 1.95; CI, 1.08 to 3.52; dusts: OR, 2.87; CI, 1.05 to 7.88) and endometriosis (solvents: OR, 2.13; CI, 0.96 to 4.72; dusts: OR, 3.63; CI, 0.99 to 13.28). Video display terminal exposure was more likely to be found among those women diagnosed with endometriosis (OR, 3.69; CI, 1.50 to 9.13) and cervical-factor infertility (OR, 2.65; CI, 0.99 to 7.12). Results suggest that among women with a medically confirmed diagnosis, fertility may be adversely affected by a variety of occupational chemical exposures.

81.) M. A. Speers, J. G. Dobbins and V. S. Miller. Occupational exposures and brain cancer mortality: a preliminary study of east Texas residents. Am J Ind Med. 1988. 13(6): 629-38.

The relationship between various occupational exposures and brain cancer was investigated in a case-control study using mortality data from 202 males who died in East Texas from gliomas in 1969-1978 and 238 male controls randomly selected from all deaths in East Texas in 1969- 1978. Using the occupational classification scheme of the U.S. Bureau of the Census, the risk for brain cancer was significantly increased for male workers employed in the transportation, communication, and utilities industries [odds ratio (OR) = 2.26, confidence intervals (CI) = 1.18-4.32]. Further examination of this finding showed that male workers employed in occupations associated with electricity or electromagnetic (EM) fields had an elevated risk for brain cancer (OR = 3.94, CI = 1.52-10.20). In addition, there was a linear relationship between the probability of exposure to EM fields and brain cancer. Significantly elevated risk for brain cancer was also found among male workers in the trucking industry.

82.) M. R. Spitz and C. C. Johnson. Neuroblastoma and paternal occupation. A case-control analysis. Am J Epidemiol. 1985. 121(6): 924-9.

The peak incidence of neuroblastoma during early infancy suggests that prezygotic or prenatal exposures to carcinogens could be implicated. Several recent epidemiologic studies have suggested an association between parental exposure to petrochemicals and ionizing radiation and the development of cancer in the offspring. This paper is a population- based case-control analysis of the birth certificate data of 157 children who died in Texas from neuroblastoma in 1964-1978 and 314 controls randomly selected from all live births in Texas. Children of fathers employed in occupations with electromagnetic field exposure were at significantly increased risk (odds ratio = 2.13). The odds ratio was 11.75 for children of fathers who reported themselves to be electronics workers (6 cases, 1 control).

83.) A. Stang, G. Anastassiou, W. Ahrens, K. Bromen, N. Bornfeld and K. H. Jockel. The possible role of radiofrequency radiation in the development of uveal melanoma. Epidemiology. 2001. 12(1): 7-12.

There are few epidemiologic studies dealing with electromagnetic radiation and uveal melanoma. The majority of these studies are exploratory and are based on job and industry titles only. We conducted a hospital-based and population-based case-control study of uveal melanoma and occupational exposures to different sources of electromagnetic radiation, including radiofrequency radiation. We then pooled these results. We interviewed a total of 118 female and male cases with uveal melanoma and 475 controls matching on sex, age, and study regions. Exposure to radiofrequency-transmitting devices was rated as (a) no radiofrequency radiation exposure, (b) possible exposure to mobile phones, or (c) probable/certain exposure to mobile phones. Exposures were rated independently by two of the authors who did not know case or control status. We used conditional logistic regression to calculate odds ratios (ORs) and 95% confidence intervals (95% CIs). We found an elevated risk for exposure to radiofrequency- transmitting devices (exposure to radio sets, OR = 3.0, 95% CI = 1.4-6.3; probable/certain exposure to mobile phones, OR = 4.2, 95% CI = 1.2- 14.5). Other

sources of electromagnetic radiation such as high-voltage lines, electrical machines, complex electrical environments, visual display terminals, or radar units were not associated with uveal melanoma. This is the first study describing an association between radiofrequency radiation exposure and uveal melanoma. Several methodologic limitations prevent our results from providing clear evidence on the hypothesized association.

84.) B. Stenberg, N. Eriksson, K. H. Mild, J. Hoog, M. Sandstrom, J. Sundell and S. Wall. Facial skin symptoms in visual display terminal (VDT) workers. A case- referent study of personal, psychosocial, building- and VDT-related risk indicators. Int J Epidemiol. 1995. 24(4): 796-803.

BACKGROUND. The Office Illness Project in northern Sweden, comprising both a screening questionnaire study of 4943 office workers and a case- referent study of facial skin symptoms in 163 subjects was recently completed. Previously published results from the survey showed that female gender, asthma/rhinitis, high psychosocial work load, visual display terminal (VDT) and paperwork were related to an increased prevalence of facial skin symptoms. METHODS. The case-referent study presented in this paper used data from the questionnaire supplemented by information from a clinical examination, a survey of psychosocial factors at work, building data and VDT-related factors from inspection and measurements taken at the work site. RESULTS. Psychosocial conditions and exposure to electromagnetic fields or conditions associated with such factors were related to an increased occurrence of skin symptoms. The results also indicated that personal factors such as atopic dermatitis and physical exposure factors influencing indoor air quality, such as paper exposure and cleaning frequency were related to an increased prevalence of symptoms. CONCLUSIONS. The results suggest that skin symptoms reported by VDT users have a multifactorial background.

85.) G. M. Swanson and P. B. Burns. Cancer incidence among women in the workplace: a study of the association between occupation and industry and 11 cancer sites. J Occup Environ Med. 1995. 37(3): 282-7.

Few studies of the occupational etiology of cancer have focused upon the risks that women experience in the workplace. In this case-referent study of 11 cancer sites (lung, colon, rectum, bladder, esophagus, liver, salivary gland, stomach, eye, melanoma of the skin, mesothelioma), 7686 women in the Detroit area were interviewed to obtain lifetime histories of employment, tobacco use, and adult health, as well as demographic information. The results provide both methodologic and substantive leads for future investigations of the association between women's employment and their risk of cancer. We found that 63% of respondents had a usual occupation of housewife. Methodologic issues are discussed about the implications of this finding for sample size and statistical analysis when conducting such studies. New observations that merit further investigation include an association between salivary gland cancer and employment in hairdressing shops, esophageal cancer and employment in restaurants, and bladder cancer and employment in computer manufacturing. Further research is needed to understand the occupational etiology of cancer among women; such studies must consider specific methodologic issues.

86.) S. Szmigielski. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. Sci Total Environ. 1996. 180(1): 9-17.

Cancer morbidity was registered in the whole population of military career personnel in Poland during a period of 15 years (1971-1985). Subjects exposed occupationally to radiofrequencies (RF) and microwaves (MW) were selected from the population on the basis of their service records and documented exposures at service posts. The population size varied slightly from year to year with a mean count of about 128,000 persons each year; each year about 3700 of them (2.98%) were considered as occupationally exposed to RF/MW. All subjects (exposed and non- exposed to RF/MW) were divided into age groups (20-29, 30-39, 40-49 and 50-59). All newly registered cases of cancer were divided into 12 types based on localisation of the malignancy; for neoplasms of the haemopoietic system and lymphatic organs an additional analysis based on diagnosis was performed. Morbidity rates (per 100,000 subjects annually) were calculated for all of the above localisations and types of malignancies both for the whole population and for the age groups. The mean value of 15 annual rates during 1971-1985 represented the respective morbidity rate for the whole period. Morbidity rates in the non-exposed groups of personnel were used as 'expected' (E) rates for the exposed subjects, while the real morbidity rates counted in the RF/MW-exposed personnel served as 'observed' (O) rates. This allowed the calculation of the observed/expected ratio (OER) representing the odds ratio for the exposed groups. The cancer morbidity rate for RF/MW- exposed personnel for all age groups (20-59 years) reached 119.1 per 100,000 annually (57.6 in non-exposed) with an OER of 2.07, significant at $P < 0.05$. The difference between observed and expected values results from higher morbidity rates due to neoplasms of the alimentary tract (OER = 3.19-3.24), brain tumours (OER = 1.91) and malignancies of the haemopoietic system and lymphatic organs (OER = 6.31). Among malignancies of the haemopoietic/lymphatic systems, the largest differences in morbidity rates between exposed and non-exposed personnel were found for chronic myelocytic leukaemia (OER = 13.9), acute myeloblastic leukaemia (OER = 8.62) and non-Hodgkin lymphomas (OER = 5.82).

87.) H. Taskinen, P. Kyyronen and K. Hemminki. Effects of ultrasound, shortwaves, and physical exertion on pregnancy outcome in physiotherapists. J Epidemiol Community Health. 1990. 44(3): 196-201.

STUDY OBJECTIVE--The aim of the study was to investigate whether occupational exposure among physiotherapists is associated with spontaneous abortion or congenital malformation in the offspring. DESIGN--The study was a retrospective nested case-control study, where the pregnancy outcome data were based on the medical registers. SETTING- -All registered physiotherapists in Finland who had become pregnant during the study period were included in the study. SUBJECTS--Cases were defined as women who had been treated for spontaneous abortion during 1973-1983 or had delivered a malformed child during 1973-1982. One pregnancy per woman was randomly selected for the study. Three age matched (+/- 18 months) controls were selected for each abortion case and five for each malformation case. The final study population was 204 cases and 483 controls in the spontaneous abortion study, and 46 cases and 187 controls in the congenital malformation study. MEASUREMENTS AND MAIN RESULTS--Exposure information was collected by mailed questionnaires from 1329 women. The response rate was 92% in the spontaneous abortion study, and 89% in the congenital

malformation study. Heavy lifting (including patient transfers) was associated significantly with spontaneous abortion. Exposure to ultrasound and shortwaves showed about threefold odds ratios for spontaneous abortions occurring after the 10th week of gestation but in analysis where potential confounding variables were controlled, neither reached statistical significance. Deep heat therapies together, and shortwaves alone, were associated significantly with congenital malformations, but the increase was found in the lower exposure category only. From the potential confounding variables, previous abortion (spontaneous or induced) was associated significantly with spontaneous abortion, and febrile disease in early pregnancy was associated with congenital malformation. CONCLUSION--Physical exertion during early pregnancy seems to be a risk factor for spontaneous abortion. The findings raise suspicion of the potential harmful effect of shortwaves and ultrasound on the pregnancy, but no firm conclusion can be drawn on the bases of these results alone.

88.) T. L. Thomas, P. D. Stolley, A. Stemhagen, E. T. Fontham, M. L. Bleecker, P. A. Stewart and R. N. Hoover. Brain tumor mortality risk among men with electrical and electronics jobs: a case-control study. J Natl Cancer Inst. 1987. 79(2): 233-8.

Brain tumor risk associated with electrical and electronics jobs and with occupational exposure to microwave and radiofrequency (MW/RF) electromagnetic radiation was evaluated with the use of data from a death certificate-based case-control study of brain tumors and occupational risk factors in northern New Jersey, Philadelphia, PA, and southern Louisiana. Next-of-kin of 435 white men who died of a primary brain tumor and of 386 controls who died from other causes were interviewed to obtain information on lifetime occupational history and other factors that might be related to excess brain tumor risk. The relative risk (RR) for all brain tumors was elevated among men exposed to MW/RF radiation [RR = 1.6; 95% confidence interval (CI) = 1.0, 2.4] and was significantly elevated among men exposed for 20 or more years. All of the excess risk for MW/RF radiation-exposed subjects was derived from jobs that involved the design, manufacture, repair, or installation of electrical or electronic equipment (RR = 2.3; 95% CI = 1.3, 4.2), while risk of brain tumors among MW/RF radiation-exposed subjects who never worked in electrical or electronics jobs was not elevated (RR = 1.0; 95% CI = 0.5, 1.9). Furthermore, risk was elevated for electronics workers who were considered to have no exposure to MW/RF radiation. Among electrical and electronics workers, risk was highest for engineers, teachers, technicians, repairers, and assemblers combined (RR = 3.9; 95% CI = 1.6, 9.9) and was limited to excess risk from astrocytic tumors (RR = 4.6; 95% CI = 1.9, 12.2). Risk of astrocytic tumors among these electronics manufacture and repair workers increased with duration of exposure to tenfold among those employed for 20 or more years. Among electricians and power and telephone linemen combined (electrical tradesmen), the RR for astrocytic tumors was slightly elevated, but not statistically significant (RR = 1.8), and showed no consistent evidence of a duration- response relationship. Electrical tradesmen are exposed to extremely low frequency electromagnetic radiation, while men in some jobs associated with electronics manufacture and repair are exposed to electromagnetic radiation in the very high frequency and ultra-high frequency ranges and also may be exposed to soldering fumes, solvents, and a variety of other chemicals.

89.) S. Tornqvist, B. Knave, A. Ahlbom and T. Persson. Incidence of leukaemia and brain tumours in some "electrical occupations". Br J Ind Med. 1991. 48(9): 597-603.

A 19 year follow up study was conducted to explore the association between occupations expected to be exposed to electromagnetic fields and the occurrence of leukaemia and brain tumours. Incidence of cancer between 1961-79 was calculated and the standardised morbidity ratio (SMR) with a 95% confidence interval (95% CI) was related to that of all Swedish working men. For all the selected "electrical occupations" the SMRs for total leukaemia and brain tumours were near unity. Increased risks were noted for all leukaemia among electrical/electronic engineers and technicians, (SMR 1.3; 95% CI 1.0- 1.7) as well as in the sub-groups of telegraph/telephone (2.1; 1.1-3.6) and machine (2.6; 1.0-5.8) industries. Risk for chronic lymphoid leukaemia was increased in the same occupational category (1.7; 1.1- 2.5) and in the sub-group of machine industry (4.8; 1.0-14.0), as well as for all linesmen (2.0; 1.0-3.5) and power linesmen (2.8; 1.1-5.7). Risk for acute myeloid leukaemia was increased among all miners (2.2; 1.0-4.1) and miners working in iron/ore mines (5.7; 2.1-12.4). Increased risk for all brain tumours (2.9; 1.2-5.9) and glioblastomas (3.4; 1.1-8.0) appeared among assemblers and repairmen in radio and TV industry. Raised risk for all brain tumours was seen for all welders (1.3; 1.0-1.7) and welders in iron/steel works (3.2; 1.0-7.4) and risk for glioblastomas was also increased for all welders (1.5; 1.1-2.1). No major changes in relative risk estimates were noted after the exclusion of persons who were over 65 at the time of diagnosis.(ABSTRACT TRUNCATED AT 250 WORDS)

90.) T. Tynes, A. Andersen and F. Langmark. Incidence of cancer in Norwegian workers potentially exposed to electromagnetic fields. Am J Epidemiol. 1992. 136(1): 81-8.

The risk of cancer was investigated in a cohort of 37,945 male Norwegian electrical workers for whom information on job description was collected from 1960 census data and linked to the 1970 census data. The standardized incidence ratio was calculated for all cancer sites in the overall cohort by comparison with national incidence rates for economically active men at the 1960 census. The standardized incidence ratios for cancers of the breast, pleura (mesothelioma), larynx, and bladder and for soft tissue sarcoma were elevated, while those for non- Hodgkins and Hodgkins lymphoma were lower. The standardized incidence ratio for leukemia for electrical workers with 10 or more economically active years was 1.41. The standardized incidence ratio for brain tumors in this subgroup of electrical workers was 1.14. These results from a large, national, population-based study at the Cancer Registry of Norway give support to previous findings of a possible association between electrical work and the risk of leukemia.

91.) T. Tynes, M. Hannevik, A. Andersen, A. I. Vistnes and T. Haldorsen. Incidence of breast cancer in Norwegian female radio and telegraph operators. Cancer Causes Control. 1996. 7(2): 197-204.

Exposure to electromagnetic fields may cause breast cancer in women if it increases susceptibility to sex-hormone-related cancer by diminishing the pineal gland's production of melatonin. We have studied breast cancer incidence in female radio and telegraph operators with potential exposure to light at night, radio frequency (405 kHz-25 MHz), and, to some extent, extremely low frequency fields (50 Hz). We linked the Norwegian Telecom cohort of female radio and telegraph operators working at sea to the Cancer Registry of Norway to study incident cases of breast cancer. The cohort consisted of

2,619 women who were certified to work as radio and telegraph operators between 1920 and 1980. Cancer incidence was analyzed on the basis of the standardized incidence ratio (SIR), with the Norwegian female population as the comparison group. The incidence of all cancers was close to unity (SIR = 1.2). An excess risk was seen for breast cancer (SIR = 1.5). Analysis of a nested case-control study within the cohort showed an association between breast cancer in women aged 50+ years and shift work. In a model with adjustment for age, calendar year, and year of first birth, the rate ratio for breast cancer associated with being a radio and telegraph operator--in comparison with all Norwegian women born 1935 or later--analyzed with Poisson regression, was 1.5 after adjustment for fertility factors. These results support a possible association between work as a radio and telegraph operator and breast cancer. Future epidemiologic studies on breast cancer in women aged 50 and over, should address possible disturbances of chronobiological parameters by environmental factors.

92.) T. B. Weyandt, S. M. Schrader, T. W. Turner and S. D. Simon. Semen analysis of military personnel associated with military duty assignments. Reprod Toxicol. 1996. 10(6): 521-8.

A collaborative study between the U.S. Army Biomedical Research and Development Laboratory (USABRDL) and the National Institute for Occupational Safety and Health (NIOSH) was designed to assess fecundity of male artillery soldiers with potential exposures to airborne lead aerosols. Potential exposure assessment was based upon information provided in an interactive questionnaire. It became apparent from extensive questionnaire data that many soldiers in the initial control population had potentially experienced microwave exposure as radar equipment operators. As a result, a third group of soldiers without potential for lead or microwave exposures, but with similar environmental conditions, was selected as a comparison population. Blood hormone levels and semen analyses were conducted on artillerymen (n = 30), radar equipment operators (n = 20), and the comparison group (n = 31). Analysis of the questionnaire information revealed that concern about fertility problems motivated participation of some soldiers with potential artillery or microwave exposures. Although small study population size and the confounding variable of perceived infertility limit the reliability of the study, several statistically significant findings were identified. Artillerymen who perceived a possible fertility concern demonstrated lower sperm counts/ejaculate (P = 0.067) and lower sperm/mL (P = 0.014) than the comparison group. The group of men with potential microwave exposures demonstrated lower sperm counts/mL (P = 0.009) and sperm/ejaculate (P = 0.027) than the comparison group. Variables used to assess endocrine, accessory sex gland, and sperm cell function were not different than the comparison group. Additional studies, incorporating larger numbers of individuals, should be performed in order to more optimally characterize potential lead and microwave exposure effects on male fecundity.

93.) J. R. Wilkins, 3rd and R. A. Koutras. Paternal occupation and brain cancer in offspring: a mortality-based case-control study. Am J Ind Med. 1988. 14(3): 299-318.

A mortality-based case-control study of selected risk factors for childhood brain tumors was undertaken. Ohio-born children who died from brain cancer during the 1959-1978 vicennium were compared to control children (of the same age, race, and sex) by using information obtained from the subjects' birth certificates. Differences between the case

and the control children with respect to paternal occupation, the focus of the study, were examined. Controlling for the potentially confounding effects of several nonoccupational factors, case fathers were found more likely than control fathers to have been employed (at the time of birth of their children) in agriculture, in metal-related jobs, in structural work jobs in the construction industry, and in electrical assembling, installing, and repairing occupations in the machinery industry. Although the results must be interpreted with caution, the findings lend support to the hypothesis that parental occupation is a potential risk factor for childhood brain tumors.

94.) J. R. Wilkins, 3rd and V. D. Hundley. Paternal occupational exposure to electromagnetic fields and neuroblastoma in offspring. Am J Epidemiol. 1990. 131(6): 995-1008.

Investigators in Texas have reported an association between paternal employment in jobs linked with exposure to electromagnetic fields and risk of neuroblastoma in offspring. In an attempt to replicate this finding, the authors conducted a case-control study in Ohio. A total of 101 incident cases of neuroblastoma were identified through the Columbus (Ohio) Children's Hospital Tumor Registry. All cases were born sometime during the period 1942-1967. From a statewide roster of birth certificates, four controls were selected for each case, with individual matching on the case's year of birth, race, and sex, and the mother's county of residence at the time of the (index) child's birth. Multiple definitions were employed to infer the potential for paternal occupational exposure to electromagnetic fields from the industry/occupation statements on the birth certificates. Case-control comparisons revealed adjusted odds ratios ranging in magnitude from 0.5 to 1.9. For two of the exposure definitions employed--both of which are similar to one used by the Texas investigators--the corresponding odds ratios were modestly elevated (odds ratios = 1.6 and 1.9). Notably, the magnitude of these odds ratios is not inconsistent with the Texas findings, where the exposure definition referred to yielded an odds ratio of 2.1. Because the point estimates in this study are imprecise, and because the biologic plausibility of the association is uncertain, the results reported here must be interpreted cautiously. However, the apparent consistency between two independent studies suggests that future evaluation of the association is warranted.

95.) J. R. Wilkins, 3rd and T. Sinks. Parental occupation and intracranial neoplasms of childhood: results of a case-control interview study. Am J Epidemiol. 1990. 132(2): 275-92.

In 1983-1984, the authors conducted a case-control study of environmental factors and childhood brain tumor risk. Cases (n = 110) were identified through the tumor registry of a pediatric hospital and matched controls (n = 193) through random digit dialing. In addition to parental occupational histories, telephone interviews elicited information about potential confounders and hypothesized risk factors for childhood brain tumors. Relying primarily on the Hoar et al. (J Occup Med 1980;22:722-6) job-exposure matrix, the authors examined parental employment characteristics in relation to the relevant developmental periods. Paternal employment in several industries (agriculture, construction, metal, and food and tobacco) and in several occupations (agriculture, benchwork, and transportation) was associated with excess risk. The range of notably elevated odds ratios was 2.0- 3.3, with all confidence intervals including 1.0 except one. Elevated but unstable odds ratios were also found for both paternal and maternal

employment in jobs "clustered" together because of common exposures. For both approaches to exposure classification, the greatest excess risks were consistently demonstrated for parental jobs held in the preconception period. Job-exposure matrix analyses indicated that case fathers were more likely than control fathers to have had jobs linked with aromatic amino and aromatic nitro compounds (range of notably elevated (and unstable) odds ratios, 3.4-4.4), but here the greatest excess risks were exhibited in the postnatal period. Few associations emerged for maternal employment characteristics, although this is probably explained by the relatively small number of women employed in jobs outside the home.

96.) J. R. Wilkins, 3rd, J. A. McLaughlin, T. H. Sinks and E. J. Kosnik. Parental occupation and intracranial neoplasms of childhood: anecdotal evidence from a unique occupational cancer cluster. Am J Ind Med. 1991. 19(5): 643-53.

Near the end of the data-collection phase of a case-control interview study of environmental factors and childhood brain tumors, an unusual space-time cluster was revealed. Not only had six genetically unrelated children been diagnosed with a primary intracranial tumor in a recent 2.4 year period in a rural county in Ohio, but each child had one parent employed by the same company (two mothers, four fathers). This represents an observed/expected ratio greater than 70 (p much less than 0.001). All tumors were microscopically confirmed, and all case parents worked at the facility in question for at least 1 year prior to conception, during the index pregnancy, and for at least 6 months after birth. The place of parental employment was an electronics firm (Standard Industrial Classification [SIC] group number 367, electronic components and accessories), where more than 100 chemical compounds are used by the company in a manufacturing process. Results of the cluster investigation are described, including a description of the case series. This cancer cluster is unique in that the index case series is composed of the offspring of workers, not the workers themselves.

97.) G. Wingren, A. Hallquist, A. Degerman and L. Hardell. Occupation and female papillary cancer of the thyroid. J Occup Environ Med. 1995. 37(3): 294-7.

This article presents the joint results of two Swedish case-control studies regarding occupational exposure and female papillary thyroid cancer. Questionnaires inquiring about lifetime occupations and specific occupational exposures were mailed to cases and controls, aged 20 to 70 years. Some 185 female papillary or mixed cancer cases and 426 female controls were included in the analysis. Increased risks were seen for women who had worked as a dentist/dental assistant, teacher, shoemaker, or warehouse worker. In addition, occupational contacts with undefined chemicals, x-rays, or video display terminals were indicated as risk factors.

Abstracts are unavailable for the following books, reports, and articles:

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2. Kalyada TV, Fukalova PP, Goncharova NN (1974) Biologic effects of radiation in the 30-300 mhz range. In P. Czerski, K. Ostrowski, M.L. Shore, C. Silverman, M.J. Suess, and B. Waldeskog (eds.), Biologic Effects and Health Hazards of Microwave Radiation, Polish Medical Publishers, Warsaw, pp. 52-57

3. Klimkova-Deutschova E. (1974) Neurologic findings in persons exposed to microwaves. In P. Czerski, K. Ostrowski, M.L. Shore, C. Silverman, M.J. Suess, and B. Waldeskog (eds.), Biologic Effects and Health Hazards of Microwave Radiation, Polish Medical Publishers, Warsaw, pp. 268-272

4. Pazderova J, Pickova J, and Bryndova V. (1974) Blood proteins in personnel of television and radio transmitting stations. In P. Czerski, K. Ostrowski, M.L. Shore, C. Silverman, M.J. Suess, and B. Waldeskog (eds.), Biologic Effects and Health Hazards of Microwave Radiation, Polish Medical Publishers, Warsaw, pp. 281-288

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